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COMPRESSED AIR CLOCKS.

THE utilization of the elastic properties of atmospheric air is of very ancient date, and has gradually developed into instances of almost daily occurrence. Air condensed at pressures varying from a little over one atmosphere up to over a hundred times the atmospheric or natural pressure has been and is used in reference to many processes or purposes. One of its most recent uses is its application for moving and regulating clocks. The question of pneumatic or compressed air clocks illustrates another very useful and important application of compressed air, and one most likely to produce a revolution in the great industry of clockmaking. An immense amount of labor, skill, and ingenuity has at all times been bestowed upon improving and perfecting apparatus intended for measuring time. Although in many instances perfection may almost be said to have been reached, this result has not, by some, been deemed satisfactory, and various attempts, more or less successful, have been, and are still being, made at simultaneously working a certain number of clocks from one central or principal one. Electricity, that mysterious, expensive, and often capricious agent, had, until lately, conclusively been depended upon for the realization of that desirable end; but no thoroughly satisfactory result has yet been obtained by the numerous attempts made to electrically distribute the time on a large scale. In 1864 a first, but unsuccessful, attempt was made to transmit the time by means of compressed air. Messrs. Popp and Resch, two Austrian engineers, were more successful at a later period.

After many disappointments, they were at last enabled, on February 28, 1877, to inaugurate, at Vienna, the first public service of distribution of time by means of compressed air. But this was merely experimental, and carried out at the expense of the inventors. When a proposal was made in 1880 to the municipal authorities of Vienna to pneumatically supply the time to the city, the authorities declined to grant a monopoly for fifty years asked for. But the public of Vienna had become so used to "regular hours" by that time that the matter was warmly taken up, and the municipality are now willing to accept what they had formerly refused, and an arrangement satisfactory to both parties has now been concluded.

Mr. Popp exhibited his system at the Paris Exhibition in 1878, where it attracted much attention, the inventor receiving a silver medal. The utility of the system induced the Paris Municipality in November of the same year to give permission to Mr. Popp to lay down pipes in the sewers of the first, second, and ninth arrondissements of the city. A month later a further authorization was granted him for distributing pneumatic time into private dwellings. A company, the Compagnie générale des Horloges pneumatiques, was soon after formed, and on March 15, 1880, the inauguration of the public service took place; six miles of pipes having been laid down and four clocks (some with multiple dials) fixed on lampposts on the Boulevards, and receiving the pneumatic time from the central works. The clocks have continued to work satisfactorily, and they are now an established institution, the public regulating their watches from the pneumatic clocks. Since then, the system has been still further extended, and at the present time nearly sixteen miles of main pipes are laid down in the sewers; and 500 houses, in which there are over 2,000 pneumatic clocks, are actually connected with and are receiving time from the central works, while fourteen public clocks with thirty-three dials have been installed in the thoroughfares of the above arrondissements.

At the central works in Paris, which are illustrated by Figs. 1, 2, and 3, in these pages, the air is compressed

FIG. 3.—AIR PUMPS.

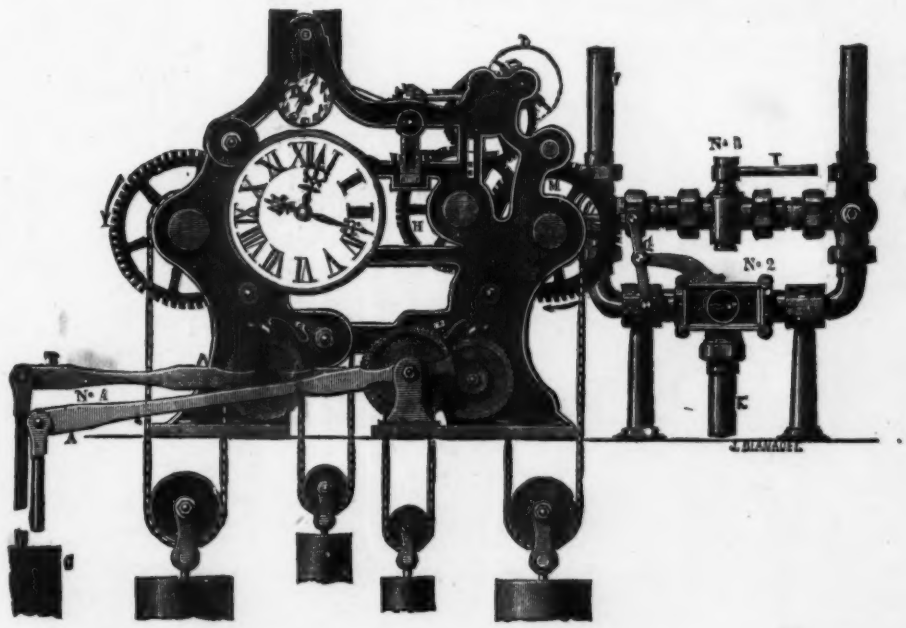


FIG. 4.—NORMAL REGULATING CLOCKS.

COMPRESSED AIR CLOCKS.

COMPRESSED-AIR CLOCKS.

Fig. 1.—CENTRAL CLOCKS, PRESSURE REGULATOR AND CONTROLLING APPARATUS.

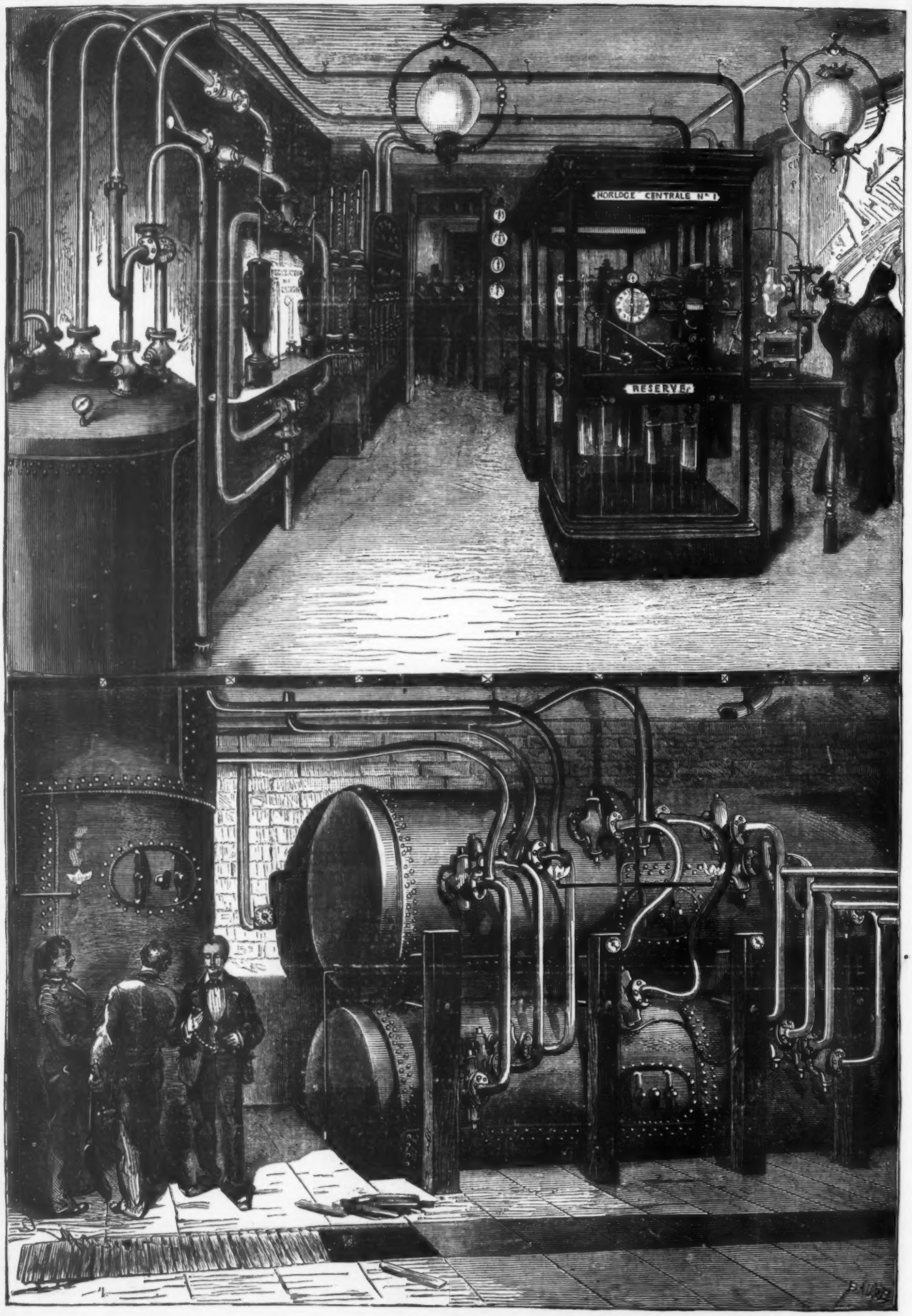


Fig. 2.—GREAT AIR RESERVOIR.

by means of steam-engines working air-compressing machines, and stored in air receivers or reservoirs, at a pressure varying from 15 lb. to 45 lb. to the square inch. The air so compressed and stored is led into distributing receivers, after passing through a pressure regulator, which forms the intermediary between the high-pressure receiver and the distributing receiver, and by means of which a periodic transfer or discharge of compressed air from the high-pressure receiver into the distributing one takes place, replacing the quantity of air which is discharged every minute from the distributing receiver into the pipes for actuating the clocks. The pressure of the compressed air in the distributing receiver is therefore constant.

The central or main clock (see Fig. 4, first page) controlling the system of pneumatic clocks, is a pendulum clock of great precision and perfection of mechanism, and to it is connected a peculiar contrivance, L H, especially adapted for the working of an equilibrium or balanced slide valve, R, which is successively opened and shut by the action of the main clock. The latter is self-winding, that is to say, the counterweights which are driving it are constantly being brought back to the former position by the action of the compressed air acting on a piston contained in cylinder, C, and by means of the intermediate lever, B, and this at each

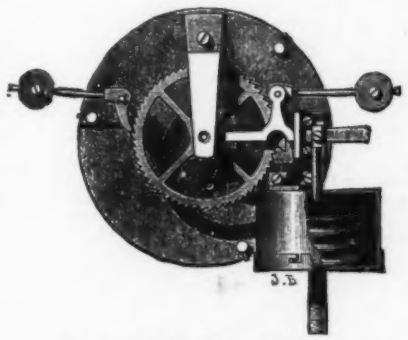


FIG. 5.—RECEIVING CLOCK.

pulsation of the compressed air. The hands of the main clock are traveling in exactly the same manner as those of any ordinary clock, and the valve, the motion of which is dependent upon the mechanism propelling the second hand, D, moves twice every minute. The first operation, opening the valve, takes place at the sixtieth second of every minute, and the second operation, shutting the valve, twenty seconds after, so that the valve remains open and admits compressed air into the system of pipes for the space of twenty seconds, at the end of which time, the valve working backwards, the air is discharged into the atmosphere through the exhaust pipe, K. This space of time allowed is the result of experience, and may be varied according to the distances which the compressed air has to travel. The valve chest is in direct communication, by means of the pipe, J, with the distributing air receiver, in exactly the same manner as the valve chest of a steam engine is in communication with the steam boiler; it thus contains compressed air always at a constant pressure.

Therefore, when the valve is opened by the action of the main clock, there is a flow of compressed air into the system of pipes, and all the clocks branched upon that line of tubing are actuated at the same time. A duplicate main clock with its valve attached is kept going exactly the same time as the other, the valve being disconnected, so that in case of anything happening to the main clock, the connection of the supplementary clock with its valve is instantly and automatically made, and there is thus no interruption in the distribution of time. The pressure of the compressed air in the high pressure and distributing receivers, the motion of the main clock and its duplicate, as well as the self-winding mechanism and motion of the slide valve, etc., are all automatically controlled, so as to require a minimum amount of supervision, anything abnormal occurring being instantly and automatically signaled.

The movements of the receiving clock (Fig. 5) are made as simple as possible. Besides the ordinary minute wheels, they have a wheel of sixty teeth, controlled by a catch fixed upon a lever, which receives its motion from a bellows of prepared leather, upon which rests a rod jointed to this lever. Another catch prevents the wheel from returning upon itself when once the movement is made. When at each minute the pressure is conveyed in the system of pipes, the bellows of each of the clocks expands, and causes the wheel to advance one tooth, and the hand a minute. A click, fixed upon the movement plate, prevents the lever from advancing the wheel more than one tooth at a time.

As we have already remarked, the pipes actually laid down at Paris have a length of 16 miles. At the center the system of pipes radiates into nine branches leading to the various quarters. The diameter of these pipes is a little over 1 inch (27 millimeters). The pipes being fixed in the sewers, whenever the time is required to be delivered, an ordinary gas-cock is inserted in the main pipe opposite the customer's house, and a branch pipe laid into the building. These branches have diameters varying between ¼ inch and ⅜ inch, the ⅜ inch size being that most in use. In the building itself the diameter is reduced to ⅛ inch, as being fully sufficient to supply the pressure required. Each sub-branch leading to the clock to be regulated is supplied with another cock. Over 500 houses are thus connected at Paris in the three districts where the system has been laid down, about 18 miles of branch and sub-branch pipes being laid down besides the main piping in the sewers.

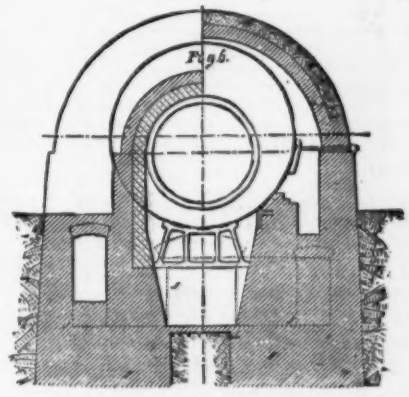
Leakages inside the houses or in the main pipes have no influence on the general working of the system; even supposing one of the main pipes to be completely smashed, the working would only be interrupted in the portion beyond the breakage, and the other mains would not be in the least affected. Leakages in houses, again, only affect those clocks the pipes of which are broken. The Compagnie générale des Horloges pneumatiques of Paris has now reached a point in the working of their clocks which insures absolute security. Convinced of their usefulness and efficiency, the Paris Municipality have concluded with the company a contract which gives to the latter a monopoly of fifty years for laying their pipes throughout the whole of Paris.—*Iron.*

BOILERS WITH CORRUGATED FLUES.

A DISTINGUISHING feature in both these boilers is that they are fitted with Fox's patent corrugated flues, of which Messrs. Schulz, Knaudt & Co. are the sole makers in Germany, and respecting which we have so frequently had to speak in favorable terms. We should add that our engravings have been copied from the illustrations of the official report of the trial, and that they evidently exaggerate the amount of the corrugation in the flue plates, Mr. Fox generally adopting for these corrugations a pitch of about 6 in. and a rise of about 1½ in.

The boiler shown by Figs. 1 to 3 is of the type known as the Pauksch boiler, and was made by Mr. H. Pauksch, of Landsberg, although both it and the other boiler illustrated were exhibited by Messrs. Schulz, Knaudt & Co., the makers of the corrugated flues. The Pauksch boiler has a shell 7 ft. 2 in. in diameter and 15 ft. 1 in. long, traversed from end to end by the corrugated flue 4 ft. 5 in. in diameter. At the back end this flue opens into a smokebox lined with firebrick, from which the products of combustion return through seventy tubes, 3 in. in diameter, to a second smokebox at the front end, from which they again traverse the boiler through two 17½ in. flues leading to the chimney. These last-mentioned flues traverse the steam space as shown in our engraving. The boiler is fitted with a dome and internal steam collecting pipe, and its chief proportions are given in the subjoined tabular statement. In the trials at Düsseldorf the boiler gave excellent results, it being fourth in order of merit, and evaporating 10·507 lb. of water into steam at 75 lb. per square inch, per pound of net coal from feed at 131° F., the result being attained when the evaporation was performed at the rate of 3·6 lb. per square foot of heating surface per hour.

The other boiler shown by Figs. 4, 5, and 6 is a Cornish boiler made by the Kölnische Maschinenbau Actien Gesellschaft, of Bayenthal-Köln, and it has a shell 31 ft. 1 in. long and 7 ft. 2¼ in. in diameter, while the corrugated flue is 4 ft. 3 in. in diameter, and placed so as to leave a clear space of 9·8 in. between it and the shell plates. The setting of the boiler is somewhat peculiar. The boiler is supported, as shown, on three cast-iron standards, there being a considerable overhang at each end. From the internal flue the products of combustion pass along under the boiler, fully one-third of the circumference of the shell being then exposed to them, while they return to the chimney through a flue which embraces all the remainder of the shell surface, as shown in Fig. 5.



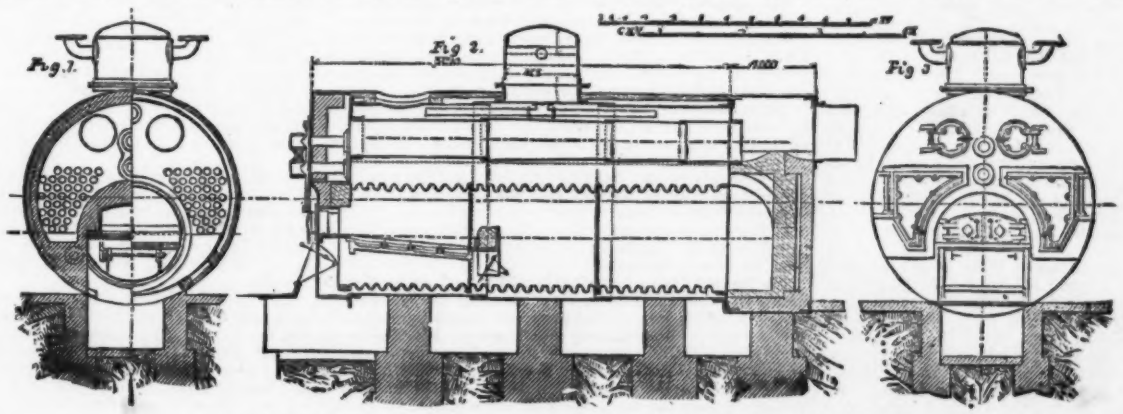
CORNISH BOILER.

Constructed by the Kölnische Maschinenbau Actien Gesellschaft, Bayenthal-Köln.

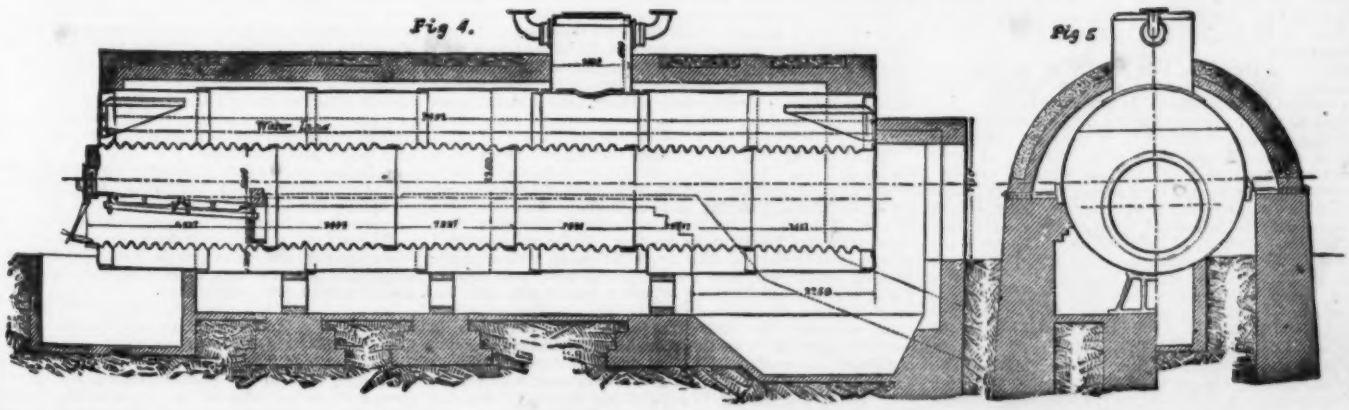
The boiler is thus entirely incased in brick work, except at the front, and exposes a very considerable portion of superheating surface. The arched upper part of the brick work is held at its springing by ties attached to the boiler shell as shown in Figs. 5 and 6. An arrangement, not shown in our illustrations, is provided for clearing the ashes, etc., out of the flue, this consisting of a perforated pipe laid along the bottom. On admitting steam to this pipe, the ashes and dirt are blown out of the flue and fall into a receptacle provided at the rear end of the setting to receive them, as shown in Fig. 4. The boiler is fitted with a dome 3 ft. 3⅛ in. in diameter and 2 ft. 7½ in. high, as shown.

During the trials at Düsseldorf, the boiler just described gave the highest results obtained, it evaporating 10·854 lb. of water in steam at 75 lb. pressure per pound of net coal burnt, and from feed at a temperature of 131° F., the evaporation being performed at the rate of 3·85 lb. per square foot of heating surface per hour.

To test the efficiency of the corrugated flue, also, a very interesting experiment was made, the products of combustion being allowed to pass off direct to the chimney after



PAUKSCH BOILER.—CONSTRUCTED BY MR. H. PAUKSCH, LANDSBERG.



BOILERS WITH CORRUGATED FLUES.

traversing the internal flue only. Under these trying conditions the boiler evaporated 8·175 lb. of water per pound of net coal from a feed temperature of 131°, the evaporation being performed at the rate of 5·918 lb. per square foot of surface per hour. Under the conditions of this latter experiment the heating surface was but 24·6 times the grate area, and the result shows that the corrugated flue surface had great power of extracting the heat from the products of combustion—a power no doubt largely due to the effect of the corrugations in causing the gases to intermingle with each other.

When dealing recently with the trials of the boilers at Düsseldorf, we gave the various proportions of the boilers which were then tested, but for convenience of reference we subjoin a tabular statement of these proportions for the boilers we now illustrate. We may add, that in the case of the Cornish boiler, the size of fire grate given, viz., 15·82 sq. ft., is that which was used during the trial; ordinarily, we believe that the makers give a grate of about 24½ sq. ft. to this size of boiler. The proportions are as follows:

	Pauksch Boiler Figs. 1, 2, 3.	Cornish Boiler. Figs. 4 5, 6.
	Sq. ft.	Sq. ft.
Heating surface, total	1,193·7	1,034 4
" in contact with water	1,038·2	841·5
Grate area, total	19·7	15·82
" between bars	8·35	3·66
Water surface	99·3	184·7
Contents of boiler:		
	Cubic ft.	Cubic ft.
Water space	274·9	633·9
Steam "	108·7	259·3
Flue area:		
	Sq. ft.	Sq. ft.
Over fire bridge	4·63	4·63
Through flue	11·99	12·99
" tubes	3·61	
" brick flue	5·6	8·2
At damper	2·3	4·4
Proportion of water surface to heating surface in contact with water	1 : 10·45	1 : 4·55
Proportion of grate area to heating surface in contact with water	1 : 50·4	1 : 53·2
Grate area between bars	2·36 : 1	4·31 : 1
Flue area over fire bridge	4·25 : 1	3·49 : 1
Area through tubes or return flue,	5·4 : 1	1·2 : 1
Area through second return flue,	3·52 : 1	1·93 : 1
	Ton. Cwt.	Ton. Cwt.
Weight of boilers	18 10	16 8¼
Contents of brick work in setting, in cubic feet	311·5	1,303·2

—*Engineering.*

LAUNCH OF THE CITY OF ROME.

The Barrow Shipbuilding Company launched from their yard on Tuesday the steamer City of Rome, which has been built to the order of the Inman Line, and intended for the Liverpool and New York station. As this steamer is the largest in the world after the Great Eastern, much interest was taken in the launch, which passed off very successfully, Lady Constance Stanley performing the ceremony of "christening." We gave an account of the City of Rome last year, but it will be convenient that we should give some particulars concerning the vessel here.

The City of Rome, which is the seventy-seventh vessel constructed by the company, is of the following dimensions: Length over all 610 ft., length between perpendiculars 586 ft., extreme breadth 52 ft. 3 in., depth of hold 37 ft., tonnage 8,826 tons, indicated horse power 10,000. It was stipulated that the vessel should combine the highest rate with the maximum of comfort and conveniences, such as are only to be found in the best modern hotels. The distinctive type of the Inman Line has not been departed from in respect of the perhaps old fashioned, but still handsome profile, with clipper bow, figurehead, and bowspirit. The figurehead is a full length figure of one of the Cæsars in the imperial purple. The whole of the headwork with this exception is formed of iron, to save the cost and trouble of continually renewing the head-rails, etc., when made of wood. The vessel is to be rigged with four masts; and here again the handsome full ship rig of the Inman Line has been adhered to, with the addition of the fore and aft rigged jigger mast, rendered necessary by the enormous length of the vessel. She will have three funnels, each painted with the company's white band.

A point calling for special notice is the large number of separate compartments formed by water-tight bulkheads, each extending to the main deck. The largest of these compartments are only about 60 ft. long; and supposing that, from collision or other cause, one of these were filled with water, the trim of the vessel would not be materially affected. The Mersey frame or post, made at the Mersey Iron and Steel Works, is the largest single forging ever made for such a purpose; the finished weight is no less than 33 tons, as compared with 18 tons, in the sternpost of the Furnessia, of 5,500 tons. The framing of the vessel is of the ordinary type, the floors being 34 in. deep at the center line. There are two complete, while the lower deck is complete for half the length, and has wide plating on each side for the remainder.

The question of propelling this great vessel at so high a speed, namely, 18 knots per hour, was one that demanded long and careful consideration. It was ultimately decided that it would be better to adhere to the single-screw arrangement, and to adapt a propeller 24 ft. in diameter, driven by three sets of inverted "tandem" engines, working on three cranks disposed at an angle of 120 deg. with one another. The "tandem" engine has the high pressure cylinder placed in a line behind or above the low-pressure cylinder. Each high-pressure cylinder is carried upon three wrought iron columns, thus giving plenty of light and easy of access to the stuffing-boxes; and also enabling the cylinder covers, which are made in halves, to be readily withdrawn. The slide valves are driven by an independent shaft, worked by two pairs of mortise wheels, one at each end of the engines, an arrangement which has the advantage of requiring comparatively small eccentrics. The crankshaft is a built shaft, and together with the screw shafting has been made by Sir Joseph Whitworth & Co., of their fluid compressed steel. The shafting is made hollow, and by the following process: Each length is made from a hollow cylindrical ingot, which while in the molten state is subjected to a heavy hydraulic pressure. The ingot is afterward reheated and placed on a mandrel, and is then forged and drawn by hydraulic pressure, until it ultimately assumes the form of a double collared shaft. The leading particulars of the engines are as follows:

There are three high-pressure cylinders 43 in. in diameter, and three low-pressure cylinders 86 in. in diameter, and 6 ft. stroke. The diameter of the crankshaft is 25 in., and of the crankpins 26 in. The length of the main bearings is 33½ in., and of the crankpins 28 in. The crankshaft, as built up complete, will weigh 64 tons; had it been made of iron and solid, the weight would have been 73 tons. The propeller shafting is 24 in. in diameter, and the hole through it 14 in. in diameter. The thrust shaft has thirteen collars, 39½ in. in diameter, giving a surface of 6,000 square inches. This piece of shafting weighs 17 tons. The propeller shaft is 25 in. in diameter, and 30½ ft. long, and weighs 18 tons. The engine bedplate weighs 100 tons. The cooling surface of the condensers is 17,000 square feet, equal to nearly 17 miles 360 yards of tubing.

There are two air-pumps, 39 in. in diameter, and 3 ft. stroke; these pumps, and the feed and bilge pumps, being worked by levers attached to the aft and forward engines. There will also be a large centrifugal pumping engine, which can either be used for pumping heavy leaks, or to discharge through the condenser. There will also be three auxiliary pumping engines, for feeding the boilers, for bilge pumping, and for deck purposes. Steam will be supplied by eight cylindrical tubular boilers, fired from both ends. Each boiler is 14 ft. mean diameter, and 19 ft. long, with a steam receiver 13 ft. long and 4 ft. in diameter, and has six furnaces 3 ft. 9 in. in diameter, three at each end, so that there are forty-eight furnaces in all. The firebars are 6 ft. long, giving a grate surface of 1,080 square feet. The shell plates of the boilers, supplied by Sir John Brown & Co., are 24 ft. 8 in. long, 4 ft. 4½ in. wide, and 1¼ in. thick, and weigh nearly 2½ tons each, all the holes are drilled. The internal parts are of Bowling iron, and each furnace has its own separate combustion chamber. These boilers are constructed for a working pressure of 90 lb. per square inch. The engines are intended to work constantly at 8,000 indicated horse power, although they are capable of developing 10,000 indicated horse power.

The internal arrangements for the comfort and convenience of the officers, crew, and passengers of the huge floating palace are to be of the most elaborate description. There are two large smoking-rooms, which will be highly decorated and fitted up in the most approved style, each saloon having a separate entrance. In the after deck-house there is a commodious saloon, which is to be furnished in the most elegant manner as a lounge for ladies. The upper saloon, or drawing-room for the use of the passengers, is a handsome apartment in the form of a wide gallery with lounges round the sides and a large rectanguler opening into the dining-room below. Above this opening is a large skylight richly ornamented. At the fore end of this saloon will be placed a grand piano, and at the after end is the staircase leading to the dining-room. The estimated weight of the vessel complete and ready for sea is 8,000 tons, and her displacement at 26 ft. mean draught is 135,0'0 tons, so that she will have a dead weight of carrying power of 5,500 tons. The cubical contents of her hold will give her a measurement capacity of 7,720 tons at 50 cubic feet to the ton.—*Engineering.*

COMMON SENSE SANITATION.

By Theo. S. Case, Kansas City.

The difficulty of securing the proper healthfulness of cities and dwellings seems to be that the people have come to regard sanitation as a "scientific" matter, to be conceived and projected only by doctors and engineers and to be executed only by expensive and predacious plumbers, by means of labyrinthine and imperfect pipes and illusory ventilators, which are prone to perverse and baneful misdirection of their contents.

The idea of "dirt" is obscured and overslaughed by technical terms like "fever germs" "bacteria," "pollution," "sewer gas," etc., until the ordinary citizen is appalled and led to regard the washing of his face or the cleansing of his cistern as the feeblest and most useless of defenses against enemies so mighty and omnipresent.

When, however, we come to examine the most perfect systems of sanitation for cities, the gigantic developments of sanitary engineering in the metropolitan cities of London, New York, etc., combined with the most modern hygienic improvements in the building of houses and the treatment of the human body, we find that the success of the whole structure depends upon

1. Personal cleanliness.
2. Household cleanliness.
3. Municipal cleanliness.

All the legislation conceivable will be of no service in preserving the health of a city unless the first of these is observed, and it is there that the work should commence.

Free baths, with whatever of compulsion is necessary to make that class of citizens use them who need them most and which class is most averse to their use, are of the first importance. Bodily cleanliness is the first step toward household neatness, for no clean family will live in a filthy house. It is this feeling, combined with the natural alarm produced by the frightful pictures and objects drawn by sanitary engineers and microscopists, that has led the people of great cities to grasp at any straw that promised relief or escape from the dangers of the specter *unsanitaries*. It has driven them from the common sense measures that would have in most cases answered every purpose, to the transfer of the personal control of their own households to municipal officers whose blundering and jobbery have inflicted great burdens of taxation as well as many physical evils upon them.

The cleansing of dwellings does not depend alone upon the use of water. Dry dirt is preferable to moist and mouldy cleanliness. Scrubbing is good sanitation only when followed by thorough drying and ventilation. Dry dirt, even on a kitchen floor, is far more tolerable, hygienically, than slops and rotten beams under the floor. Moist and mildewed papers, held to sodden walls by putrid paste, will originate diseases which could have no existence in a dry atmosphere. These evils are not remedied by sewer pipes. On the contrary they are often intensified by the addition of sewer gases escaping from defective joints. The remedy is to properly carry off from the roofs the rain which otherwise permeates the walls, and to put down kitchen floors that are impermeable to water. These precautions, with proper ventilation, will go far to render our dwellings dry and healthful.

To properly cleanse streets and alleys is to remove the filth, not by washing it partially away occasionally with a hose and leaving the remainder to ferment and fester in the sun in the nooks and corners, the interstices between the flags of the gutters, and in the mud of the macadam, but by scraping and sweeping it up and carting it away, by leaving the streets as dry as may be except from the most superficial sprinkling, by removing all the slops and garbage from the alleys, and using lime and copperas as disinfectants at all offensive localities.

A model street is one composed of a smooth, not slippery, hard material, impermeable to moisture; with its sewers opening into towers high enough to discharge the foul gases above the heads of the people, and its dust and accumulations swept or washed away at night.

Much of the pestilence which has decimated Memphis twice within the past few years was due to the condition of her streets, which had been covered with wooden pavements. "These had become much decayed, and readily absorbed much of the liquid filth that flowed over the rotten gutters, and in due course became so permeated with it that the periodical flushings of rain storms utterly failed to cleanse them, and they were the constant source of poisonous emanations."

The disposition of the sewage of a town is the most troublesome question of all, and one that is far from being settled, though millions of dollars have been expended in the large cities of the world in attempts to solve it. Manifestly the most complete and thorough solution of the matter is to burn the solid portion; the next is to bury it in the ground, and the last to discharge it through sewers into the nearest water course. The first is the most expensive, though clearly the only perfect destruction of it; the second, though a natural rendering of "earth to earth," will only answer in districts comparatively sparsely settled, while the last is that best adapted to the conveniences of most cities, though by no means satisfactory in a hygienic sense.

In London, after the Thames River had become an intolerable nuisance by reason of its filthiness as a scavenger of the immense city, the removal of the sewage was handed over to the Metropolitan Board of Works. The general plan adopted was that of intercepting sewers, which receive and convey the entire mass to outfalls far below the city, where it is discharged, twice every twenty-four hours, from immense reservoirs, upon the flood tide, and, theoretically at least, borne out to sea. At Edinburgh, where the natural facilities for its disposition are far better, the sewage and rainfall are discharged at the conveniently near sea outlet at Portobello. At Glasgow, the sewage is emptied into the Clyde, and later, the foul mud of that stream is dredged up and conveyed in barges to a deep loch more than twenty-five miles off.

In New York and Boston the most serious trouble has been experienced from the same causes, and gigantic engineering enterprises are being considered and adopted for the relief of the people from the effects of pouring such vast amounts of sewage into the streams and bays near those cities. To show how the presence of such matters affects the health of the localities where they are exposed, it is only necessary to refer to the case of Glasgow, where the sewage, though deposited in a wide and deep loch out in the country, has engendered new types of disease and converted one of the healthiest seaside resorts into a pestilential fever center. In this city our only practicable resort is to deliver our sewage into intercepting sewers, which shall conduct it to the Missouri River, at a proper distance below the city. Fortunately its rapid current is our safeguard against any possible return of it to afflict us with its evils. The main thing to guard against, then, is ill-constructed, ill-fitting, leaky pipes, through which the deadly sewer gas escapes, and, penetrating our houses, poisons our families.

When a respectable householder, in his anxiety to avail himself of every means of making his home pleasant and healthful, connects it with a main sewer, he runs a risk besides which exposure to small-pox is a trifle. He places himself at the upper end of a tube, which, if defectively valved and trapped, lead into his house, by natural laws, gases, which, evolved from the outpouring of hospitals, soap factories, slaughter houses, hotels, and dwellings, are unutterably foul and malignant. Common sense says, keep such pipes out of your houses, or if you cannot do so in cities, then see to it that the connections are made by conscientious experts who understand the dangers and their prevention, and that the main sewers are fully ventilated, and in such a way as not to force them into our dwellings, nor discharge their offensive effluvia at our prominent street corners in the faces of our wives and children as they pass by.

London suffers immeasurably from the pent-up sewer gas, which, under its system of collection and storage, inevitably accumulates in the reservoirs and pipes, and pushes its way with overpowering force through almost every obstacle presented by engineers and plumbers so that the problem of rendering a dwelling house proof against it is one of no easy solution.

Mr. Geo. E. Waring, the well known sanitary engineer, proposes separate conductors or sewers for the removal of the natural or land and surface waters, and for the removal of the artificial or house and soil drainage of cities. He also recommends the system of "pipe drainage" now in use at Memphis, the leading principles being "the restriction of the size of the sewers to a capacity barely sufficient to carry the greatest flow of the day when running half-full; the most complete and thorough ventilation of every part of the sewer; and its thorough washing, from end to end, at least once in twenty-four hours, by a suddenly discharged volume of clean water sufficient to carry forward, at least to a point where the constant flow is sufficient to keep them in motion, all solid substances delivered to the sewer by its tributary house drains, so that nothing of a putrescible character shall remain in the sewer long enough for its decomposition even to begin." This plan has succeeded admirably in Memphis, entirely preventing the formation of sewer gas in the pipes, even in the hottest weather.

In Baltimore all of the rainfall is removed by surface gutters, the experience of the people having demonstrated effectually the importance of retaining it upon the streets for cleansing purposes. The same plan might prove effectual in Kansas City, if our streets were properly paved, since the topography of the two cities is somewhat similar and our spring and summer rains are so copious as to insure perfect cleansing with every shower.

We are then fortunately able to adopt the Memphis plan for our sewers and house drains, and the Baltimore plan for the removal of the clean surface water or rainfall, with the beneficial effect of washing off our streets at the same time.

All this is common sense sanitation, and if such simple plans as these are adopted for the personal, household, and municipal cleanliness of our city, there need be little fear of pestilence.—*Kansas City Review.*

RELATIONS OF SCIENCE TO SPECULATION.

By Principal J. W. DAWSON, LL.D.

"Do we really exist? If we do, what is the thing called life?" Such are the problems that were discussed by Principal Dawson, of Montreal, a Fellow of the Royal Society and one of the best living scientists in the study of biology, in his lecture at Association Hall, Philadelphia. It was the first of a series of gratuitous lectures on "The Relations of Natural Science to Monastic and Agnostic Speculations," given under the auspices of the Crozier Theological Seminary.

If we ask, said the lecturer, what is science in relation to nature, we have before us all that men have observed of the workings and objects of nature and the deductions therefrom. But added to this is something of another sort, sometimes called philosophy, which is really a mass of material, the growth of the thoughts of the times, and this is that troublesome commodity—modern speculation. Evolutionists need the less complain of this view, as it is the natural outgrowth of their theory. It by no means follows that our knowledge of recent discoveries equals the extent of their practical application Take, for instance, electricity. Its application in a variety of ways is almost general, and yet there are very few things we know less about, either as to its laws or by what it is regulated. There is so much discovery that men are in danger of thinking themselves omniscient, but in reality the most of the accomplishments of science remain mysteries to mankind. The tendency to mad specialties of study, too, cause a great deal of general speculation, covering the whole field to be made, from a point of view that is really restricted. Then there has sprung up a demand for sensational science just as there has sprung up a demand for sensational fiction, and if it cannot be met by facts in existence, something has to be invented, for the number of half-starved scientific men who are trying to find the secrets of nature is by no means small. Moreover a great deal of supposed scientific truth is vague and does not mean one-half what is supposed. I don't know to what extent science is to be blamed, but not a few of those who have pushed speculation to its utmost have been literary men, and some of them had studied theology as well. An agnostic, you know, is literally one who doesn't know. As one of them has expressed the idea, "the existence of a God is unthinkable." The agnostic, while saying less than the atheist, means scientifically more, and steels himself against argument by saying it cannot be reasoned about at all. In the true sense no scientific man can be an agnostic. There are few of us, perhaps, who will refuse to accept the creed, "I exist," although there are some who might limit it, and yet our personal existence is a thing most incomprehensible, especially in regard to its beginning and its ending.

We are in a boundless space and time, with the beginning of either a mystery, so that it is scarcely possible for any one to admit their own existence without arousing a vestige of the religious idea. In personal existence is involved the question whether or not the vastly complex bodily organism is the first or only the outer shell. We cannot but admit that the body is vastly more mysterious since science took it up. There is a class of philosophers who think it will simplify matters to consider the individual as a material substance with two sets of properties. If by a material substance is meant a combination of elements there is no such material in existence having the qualities of mind; if it means the whole being, the statement amounts to nothing. We must admit there is something more, and that is life. Nutrition, reproduction, sensation, and voluntary motion are its functions, the last two being restricted to animal life. Herbert Spencer says life is "the continuous adjustment of internal and external relations," but that is very vague and only touches the surface. I think myself that life has the same relation to organisms that force has to matter. It is some energy, whether a combination of physical energies, or the same but correlated only with organization. It is all very well to find fault with calling the living organization "a machine," but a machine has to be made by some one and for a purpose, and there is an enormous lot of theism in the idea. Who ever heard of a machine made by nobody for nothing in particular? What is the use in talking about protoplasm as the basis of life when in point of fact protoplasm depends on life as its basis? All the white of an egg is protoplasm, but life is in the embryo cell. Protoplasm may go to make feathers and flesh and tissue, and yet the life that constitutes the chick may be elsewhere Going further, science fails to correlate the power of the human will with any physical force. It is an energy that operates only on living organs and through them on other things. Then comes the question, are we the originators of the world, or did it produce us, or is there a great third Being? If an atom is a vortex, as they say, what is it a vortex of? We talk very learnedly of laws of nature, but they are but the expressions of the controlled motion of things. Behind them lies an insoluble mystery.

In conclusion Mr. Dawson discussed the three theories of Herbert Spencer as to the origin of things, "self-existing," or "self-created," or "created by external agency," and raised a laugh by saying that the possibility of creation by an agency within had never occurred to Mr. Spencer. Mr. Dawson's deduction was that science is not inconsistent with the view of a superhuman power as explaining the origin, design, and continuance of things.—*Philadelphia Times.*

PAPER PULP FROM WOOD.

THE following interesting description of the process of making wood pulp is from an account of the opening of the Thorold Pulp Paper Company's establishment published by the *Thorold Post*, Canada:

"The wood, four feet in length and of any thickness, is brought in at the basement, placed in the barking-jack (one stick at a time), where two men, with drawn knives, rapidly peel off the bark. It is then conveyed by the elevator to the first floor, sawn in two-foot lengths with cross-cut saws, passed on to the rip saw, where it is slabbed (that is, a small portion of wood on opposite sides taken off), to permit it resting firmly in the grinding engine. It is then passed to the boring machine (an upright one and a half-inch auger, with foot attachment driven by power), where the knots are bored out. The wood is then placed in racks of the same size as the receptacle in the grinding engine and carried out to be ground. The grinding engines are upright, and receive a filling one-twentieth of a cord of wood. The wood is placed in a receptacle, and by a simple, variable, automatic process is pressed flatwise between two outward revolving rolls, composed of solid emery, which are flooded with a spray of water, carrying off the fibrillized pulp in a stream through revolving screens to the tank or stuff-chest in the basement. It is then pumped up into a vat that forms part of the wet machine). In this vat is constantly revolving a large cylinder faced with fine brass wire cloth, which picks up the particles of pulp out of the water and places them on the felt (an endless piece of woolen goods which makes between rolls, for different purposes, a continual circuit of the wet machine. On the cylinder is turning a heavy roll, called the concha; between the two, where they met, the cylinder leaves the pulp, with most of the water pressed from it. The pulp now makes its appearance on the felt above the concha roll in a beautiful sheet, 38 in. in width, and is carried along in a steady flow a distance of about 8 ft., where it passes between (the water here again being pressed from it) but not beyond two heavy rolls, the upper iron, the lower wood; it adheres to the upper roll, which is constantly turning, wrapping it up, and when a sufficient thickness is attained, is cut off by a knife being pressed to the roll attached to the machine for that purpose. It now leaves the roll in a thick, white sheet 36×38 in., which is received by the boy in attendance on a table conveniently attached to the machine, and folded into sheets 14 × 26 inches. It is then placed on scales until the weight is 100 lb., when it is placed in the press and firmly tied into square compact bundles. It is now ready for shipment to the paper mill to be made into printing and tea paper. The wood paper pulp has been placed in the market, and found a ready sale. Last week a contract to the amount of $1,000 was made with one of our large paper mills."

OIL PRESSING MACHINERY.

PERHAPS no application of the mechanical powers to manufactures can boast such antiquity as the press, by which the "wine and oil," so early reckoned among the wealth of nations, are extracted. The crushing of oil seeds by mechanical means is a comparatively recent industry in England, having been introduced into Hull from Holland about the end of the eighteenth century. The Dutch had long expressed the oil from linseed by means of pressure applied by wedges, which were driven home by falling stamps, similar to those in an ore-crushing works.

In the recent Winter Exhibition of Old Masters at Burlington House was exhibited a picture of an oil mill by David Teniers, dated 1633, the property of Earl Cowper, K.G., which gave a very accurate view of one of these mills, many of which still exist in Holland, especially about Zaandam, and which many inhabitants of Hull still remember as making a most objectionable noise day and night. Screw presses have met with but little use in seed crushing, and it was not until about 1845 that Bramah's invention was applied to this purpose. The number of mills with hydraulic presses employed in England is estimated at over 150. In the usual process of seed crushing the seed operated on—say linseed—having been screened from all dust and lumps, is passed between rolls of hard or chilled iron, which burst the outer skin, and flatten the mass of oil cells within. From the rolls the seed is thrown upon the bed-plate of a set of edge stones, similar in construction to a mortar mill, but having the runners and bed of a peculiar gritstone, the weight of the runners being some 10 tons. Beneath this the seed is triturated by the peculiar rolling and dragging motion of the runners.

After being ground for some minutes the seed is placed in a steam jacketed pan called a "kettle," in which it is agitated by a revolving stirrer and heated to about 160 deg. From the kettle the seed is withdrawn into taper woolen bags, each holding sufficient seed for a cake. These are flattened by the hand of the workman and placed between the sides of wrappers formed of thickly woven horsehair backed with leather, which is called "a hair." The hair and its contained bag of seed are then placed in the press. This press usually has spaces for four cakes one above another. The ram is 12 in. in diameter, and is worked at a pressure of 1½ tons on the square inch, this giving a pressure of about 0·55 ton on each square inch of the cake made. The pressure is given by pumps, two with 1 in. rams and two with 2½ in. rams being in one set; the larger diameter of pumps gives the pressure quickly until it reaches about 3 cwt. per square inch, when the small pumps give the final nip. The arm of the press rises by a series of impulses corresponding to the strokes of the pumps; this, like the percussive action of the stampers in the old Dutch presses, seems to extract the oil more effectively than the dead pressure of an accumulator or a screw press. We illustrate on the following pages an oil mill on an improved principle, lately erected at Wateringbury, near Maidstone, for Mr. R. Leigh, M.P., member for the latter town. The engine and machinery were designed and supplied by Messrs. Rose, Downs, and Thompson, of the Old Foundry, Hull; the turbine by Messrs. Williamson Brothers, of Kendal; and the boilers by Messrs. Galloway and Sons. The building is from the design of Mr. Friend, architect, Maidstone. The mill is situated on the Medway, at a point where a weir gives an effective fall of 6 ft. This is utilized by a turbine—A on plan, page 330—which can be thrown in and out of gear with the shafting of the mill, which is also driven by a horizontal compound condensing engine, with 15 in. and 25 in. cylinders and 4 ft. stroke. The engine is fitted with a balanced expansion valve, controlled by a Porter's governor.

The seed, which is brought by barges, is taken into the mill by a sack-lift, B, and the sacks emptied upon an India-rubber conveyor belt, C, discharging into the elevator, D, which deposits the seed upon another conveyor, E, running the whole length of the building, and capable of being reversed. From this the seed can be discharged at any point for storage in the top or other floors. These belts run at about 600 ft. per minute. The seed to be crushed is run through the revolving screens, F F, which are placed at an angle, the dust passing out in the upper portion of the mesh, and the seed in the lower, leaving any lumps to fall out at the end. From the screen the seed enters the bins, G G, each holding sufficient for eleven hours' working of four presses.

At this point the improved machinery of Messrs. Rose, Downs, and Thompson is brought into operation. The seed, instead of passing between a pair of rolls, is fed into the improved roll frame, H, Fig. 1. In the old system of crushing oil seeds the rolls had never more than 20 in. of working breadth, and were placed in couples with their axes in a horizontal plane. In these rolls the working surface is 3 ft. 6 in., and the rolls, four or more in number, have their axes in a vertical plane, similar to a train of calendering rolls. The rolls run in chocks which have free vertical motion in slots in the side frames; the seed is fed from the hopper by a grooved roller, and passes between the top or No. 1 roll and the second roll; an iron plate, which also scrapes No. 2 roll, directs the already crushed material between rolls Nos. 2 and 3, where it undergoes the extra pressure given by the weight of the two rolls above. This grinding process is repeated between the remaining rolls, with the result that the seed comes away more perfectly reduced than with the old combination of the pair of rolls with the heavy edge runners, a great reduction in space and power being effected at the same time. The crushed seed is carried from beneath the rolls by elevators, I I, which take it to creeper troughs placed on the main girders of the mill, from which it passes into the steam-jacketed kettles, K K, on plan and Figs 2 and 6. Here it is heated to about 160 deg. Fah., and agitated by the revolving arms shown in Fig. 6, and at the same time exposed to the action of a jet of steam carried by a pipe, also seen at Fig. 6, the effect of the steam being to give the amount of moisture required in pressing the cake. In the old process of seed crushing this was attained in a more primitive manner, by throwing water upon the seed while under the edge stones.

From the bottom of the kettle the meal is withdrawn in a measuring box, A, Fig. 2. This box, which holds some 18 lb. of meal, is drawn by the workman over the mould below B, of the moulding machine (Vittue's patent). This machine consists of two portions, the moulding and the compressing arrangement, which are quite independent of each other, and its action is the master key to this process of seed crushing. The machine has two side frames, *c c*, Fig. 2, upon which slides a skeleton carrier frame, D, Fig. 2. On this a light steel tray, the size of a cake, is laid, and on this a slightly wider strip of cloth, which is about twice the length of a cake, is placed; the mould, B, which is hinged to the side frame, is then closed upon it, and the bottomless measuring box, A, drawn along it, depositing its seed along the cloth and tray in the shape of the cake desired. The mould, B, is then thrown up on its hinges, the ends of the cloth doubled over the seed, and the carriers with their load pushed under the die, E. The carrier in moving throws into gear a cam, F, beneath the table, which makes four revolutions per minute. This cam raises the tray and its load off the carriers, permitting them to be drawn back, and the operation of moulding another cake proceeded with. The cam compresses the mould of meal from 3¼ in. to 1¼ in. in thickness, and then throws itself out of gear, allowing the compressed cake to be withdrawn by the pressman at the end of the die. During this process of compression the man who works the machine has another mould of meal ready to place beneath the die.

It is a curious fact that in pressing the oil from the cake in the bag, or rather folded cloth, very little or practically none of the oil passes through the cloth at the sides, the whole of the oil finding its way from the cake of crushed seed at the edges. It would appear that the seeds or seed-coverings arrange themselves in horizontal layers, and thus the easiest path for the oil is between these layers. The fact that an intermittent pressure, as by the stroke of the wedge and box presses, or, better still, by the hydraulic press plungers illustrated, extracts a larger quantity of oil than when a dead pressure like that which follows the use of an accumulator for working the presses, is also a curious one, which might be usefully remembered.

The advantages claimed by the use of this machine are: First, that the pressman is relieved of lifting the heavy hair wrappers, some 26 lb. in weight, which had to be placed in the press with each 12 lb. of meal; secondly, that there is a saving of some 30 per cent. in the woven material used for bags, in addition to which no sewing of bags is required; third, that with this machine the hydraulic press will deal with eighteen cakes of 12 lb. each, or 216 lb. of cake, while in the usual system one press only presses four 8 lb. cakes, or 32 lb. of cake; fourthly, that the hairs used in the old presses, one of which was used for each cake, and which cost some £3 or £4 each, and only lasted a year, are dispensed with. There is also a saving of labor, to which we shall refer at the end of this article. The tray of meal is placed between the plates of the press, M, and Fig. 3. These plates are corrugated—as shown at Fig. 7—and bear a brand which they impress upon the cake. The cylinders of the presses are of crucible cast steel, and are 16 in. bore, the columns being 4½ in. diameter, and the weight of each press some 7½ tons; the pressure on the ram is 1½ tons per square inch, and on the seed crushed 0·75 ton per square inch. Pressure is given by pumps, N, and Fig. 4, as described previously, and lasts about twenty-five minutes, each press being sent up as soon as filled. The oil expressed falls into the tanks, Q, placed behind each block of presses, from which it is taken by pumps to the store and measuring tanks in the oil-house. These hold some 200 tons of oil. When the ram descends the cakes are withdrawn and handed to a lad, who strips off the woolen cloth and cuts off the loose edges in the paring machine, O, Fig. 5. This machine is supplied with gauges which insure a uniform size of cake, and will pare 12 tons per eleven hours. The material cut off falls into a trough in the middle of the table containing a screw which discharges it upon the bed-plate of a very small set of edge stones, P, 4 ft in diameter, which discharge the material as it is reduced to a granular form. From these stones the meal passes into a screw creeper, R, beneath the floor of the mill; this takes it in equal proportions to the elevator, I I I, by which means it is automatically mixed in equal proportions in the kettles, K K. The gearing of the mill is supported on heavy cast iron girders secured to the walls and columns of the building. All the meeting surfaces of these girders as well as those of the columns and carriages are planed.

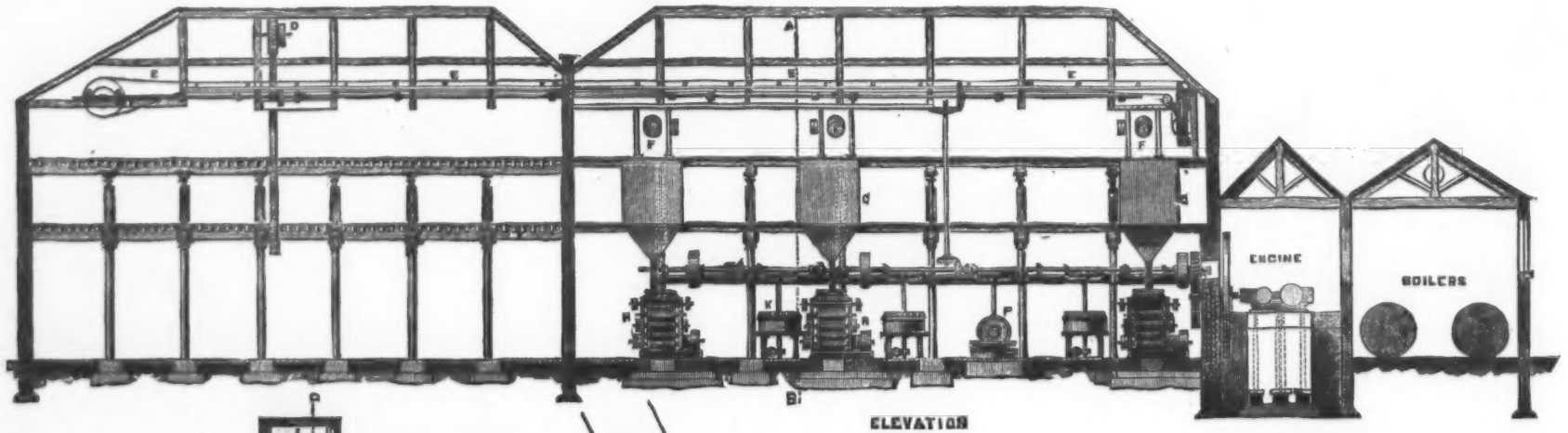
It will be seen from the plan that a set of the machinery consists of rolls, kettle, moulding machine, four presses, pumps, and paring machine. Such a quantity of machinery will crush 50 qr. of linseed in eleven hours, yielding 6 tons of cake and 3 tons of oil, the latter depending on the quality of the seed. Two men and a boy work a unit of the machinery, one man moulding and attending to the rolls and kettle, another working the press, and the boy paring and removing the cakes.

Mr. Leigh's mill is constructed to turn out 18 tons of cake per eleven hours, or 36 tons if working night and day, as is usually done in oil mills. Six men and three boys do all the work in the press room, which, under the old system, would have employed twelve men and six boys.

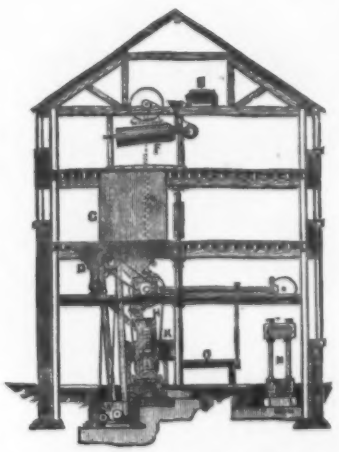
Messrs. Rose, Downs, & Thompson claim for their improved machinery the following advantages: (1) A saving in driving power equal to 20 per cent. over the old system; (2) great economy in space; (3) improved appearance, and more perfect branding of the cake, which by this process has a much better surface and fracture than that made of seed ground under edge stones; (4) the more perfect extraction of the oil; the average percentage of oil in cakes of the old make is 10½ per cent., while the new process averages 7½ per cent., thus showing a saving of 3 per cent.; (5) a saving of 50 per cent. in the labor employed in the press room, as shown above; (6) a saving in wear and tear of the bagging employed; this in the old system costs 1s. per ton of cake, and made on the improved plan about 4d. or 8d.

OIL MILL, WATERINGBURY, KENT.

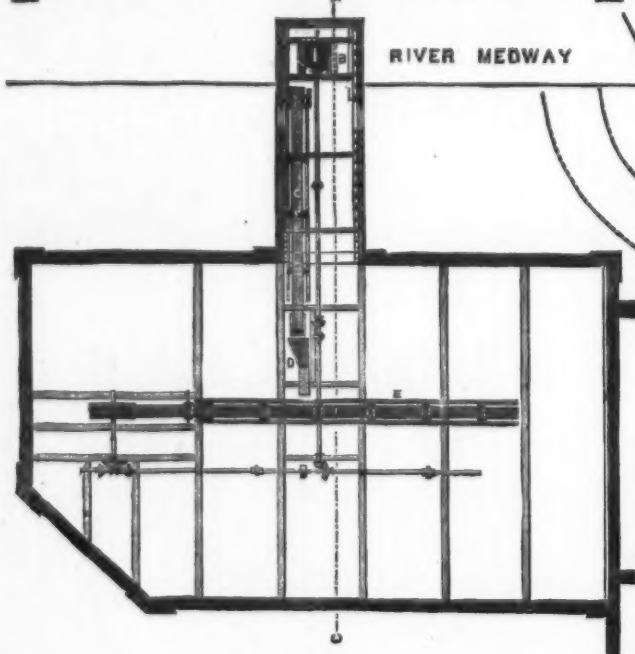
MESSRS. ROSE, DOWNS AND THOMPSON, HULL, ENGINEERS.



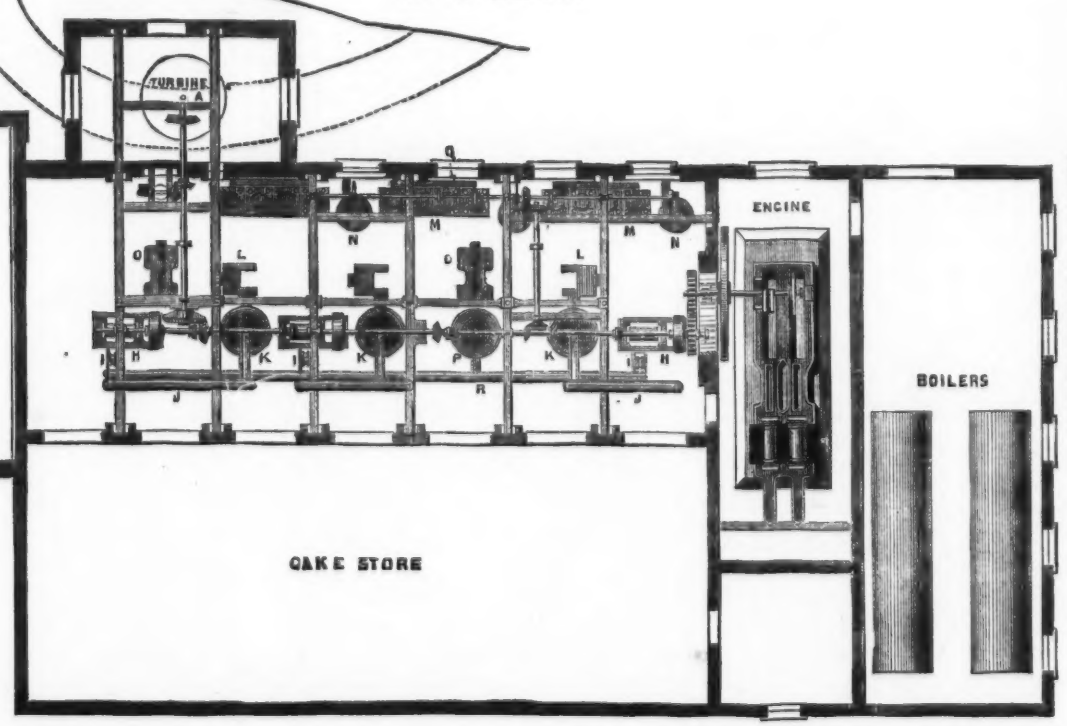
ELEVATION



SECTION THROUGH LINE A.B



PLAN



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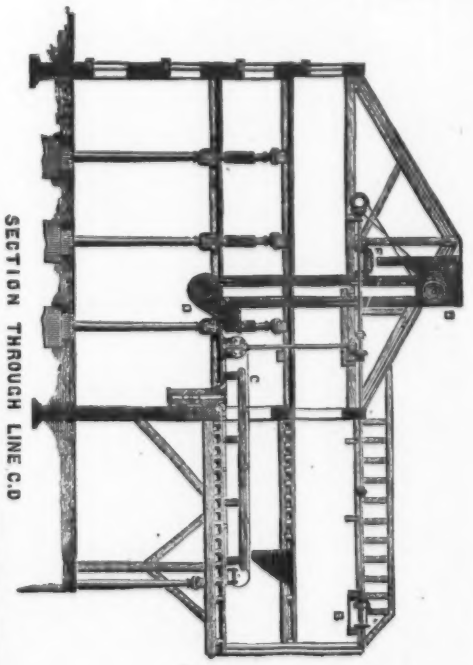
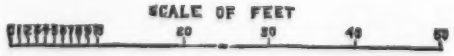
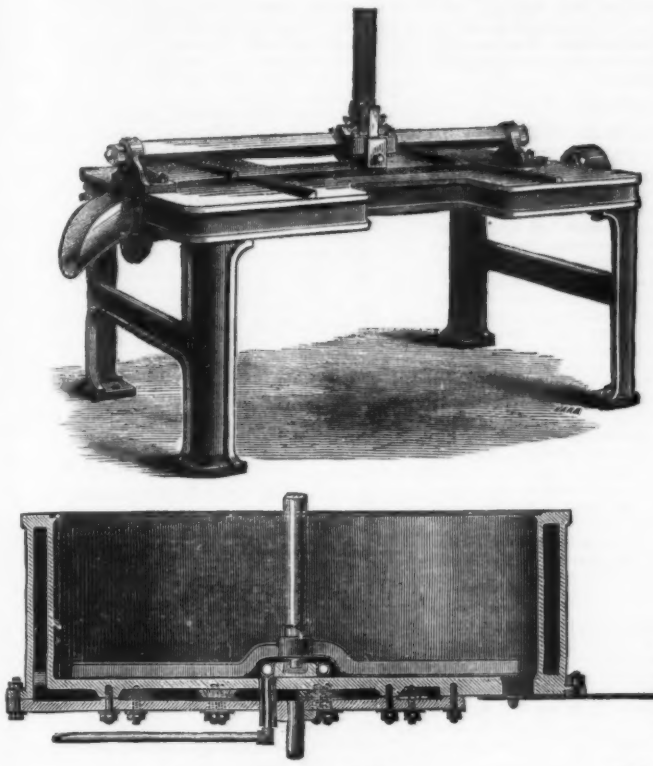


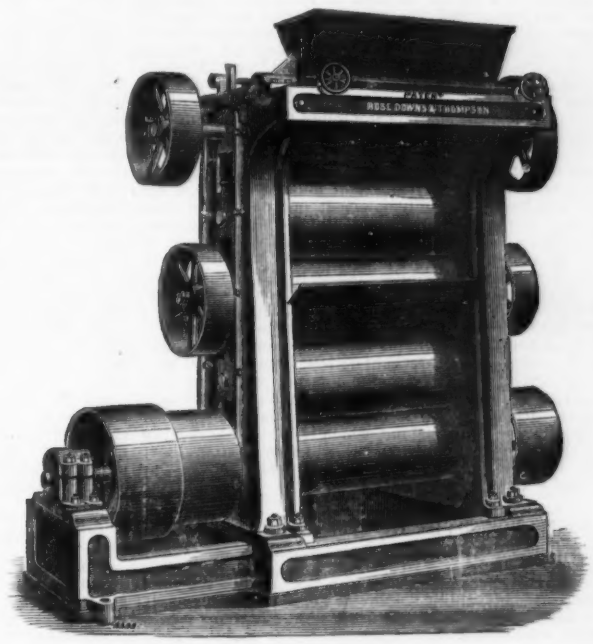
SCALE OF FEET



OIL MILL MACHINERY, WATERINGBURY OIL MILL, KENT.

MESSRS. ROSE, DOWNS AND THOMPSON, HULL, ENGINEERS.





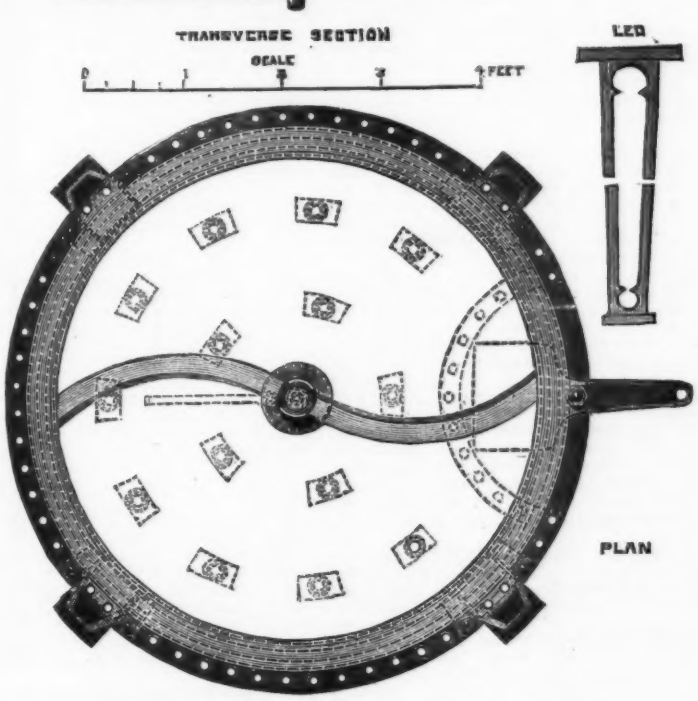


Fig. 3.

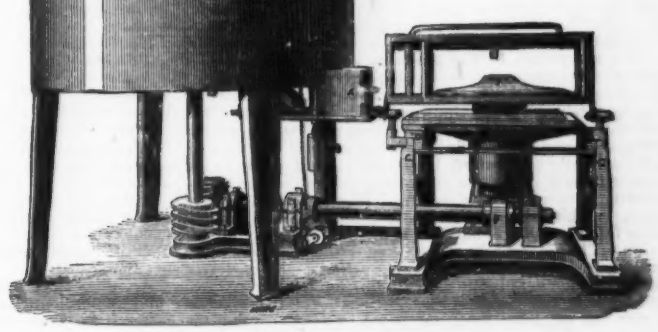
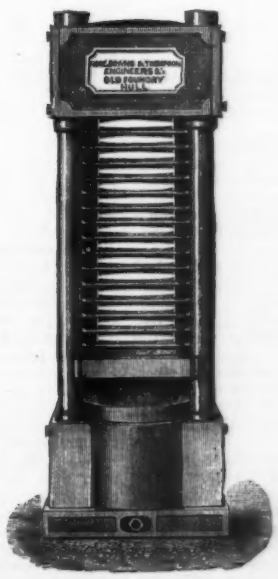
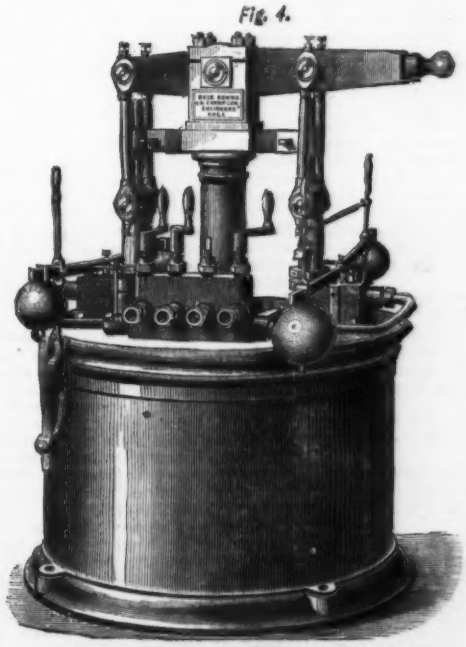


Fig. 4.





The mill we have described was designed for the crushing of linseed only, but with slight modifications in the crushing machinery the system is suitable for all other kinds of oil-producing seeds, such as cotton seed, etc. etc., and about twenty mills in England and abroad are now working successfully on this plan.—*The Engineer.*

REDUCTION OF OVER-PRINTED PROOFS.

By W. ENGLAND.

A SIMPLE and certain method of reducing over-printed proofs has been one of the wants long felt by all photographers. It is well known that in every photographic establishment, even the most careful printers cannot always be sure of getting the exact depth of tone required and proofs occasionally get over-printed. Of course, prevention is better than cure; but when a remedy is necessary, the method I am about to describe answers admirably.

I tried a great many experiments before I succeeded to my satisfaction. I found that cyanide of potassium totally destroyed the print, even when used moderately strong. By using a weaker solution it was well under control, and the exact depth could be readily obtained; but, during the washing to remove the cyanide, the action of the latter continued, and spoiled every proof. I then tried several methods to arrest the action of the cyanide, but without success. It then occurred to me to use the cyanide in such a weak state that but little should be held in the paper, only sufficient to reduce the print to the required depth. For this purpose I made a bath of only four drops of saturated solution of cyanide to a pint of water. The prints immersed at first showed no signs of getting lighter; but after about an hour the most perfect results had been obtained with prints considerably over-printed. With lighter pictures a less time is required. Proofs treated in this way lose nothing of their tone during the after-washing, which should be thoroughly done, and, when dry, retain all the brilliancy of an ordinary print. I inclose you a proof, one half treated in the way described.—*Photo. Journal.*

TO TAKE POSITIVES IN THE CAMERA DIRECT.

By J. B. OBERNETTER.*

ACCORDING to my experience, the best results are most conveniently obtained by employing collodio-bromide of silver emulsion. For the benefit of those who have not a good collodion emulsion at hand, I give below a formula for making one, by the aid of which very excellent collodio-bromide plates may be prepared. Gelatine-emulsion can only be used with advantage when it contains the smallest possible proportion of gelatine, and provided the plates are quite evenly coated; even then, those parts which in a positive should be quite clear and glassy, always show a yellowish tint, due to the action of the developer in reducing the silver bromide. The new emulsion of Dr. Vogel behaves in exactly the same way as one of pure gelatine.

When a positive is to be taken, the exposure must on no account be too short. A developer must be selected which is best adapted for use with the particular kind of emulsion employed: for instance, a collodion emulsion should be developed with bicarbonate of ammonia. The developing must be continued until the silver bromide in the darkest parts has been completely reduced throughout, an effect which may be observed by examining the plate from the back by transmitted light; fog by transmitted light, or on the front side, is of no consequence.

So soon as the development has reached this point, the plates must be thoroughly rinsed in water; a two to three per cent. solution of chromic acid is then flowed over them. The bromide that has been reduced to metallic silver is by this means rapidly converted into silver chromate, as will be at once recognized by the well-known intensely red color where the conversion has been completely carried into effect. This chromate must not be entirely removed, which may be done by washing the plate in a little water, and then in a very dilute solution of ammonia. Those parts which were at first opaque and afterwards of a red color, will now be seen to be perfectly transparent like clear glass, and the other parts will be more or less transparent in proportion to the quantity of silver bromide reduced. The result is a positive image in white silver bromide; to blacken this it must be taken into the daylight and laid in any dilute developing solution. The bicarbonate of ammonia developer gives a particularly good tone, that of Dr. Eder rather a gray one. We may continue the reduction of the bromide until every particle of it is reduced, and then we shall get the greatest depth; but we have it in our power, by interrupting the reducing process at any particular point, to produce a soft or hard positive. Finally, the image is fixed with sodium hyposulphite. This method is very advantageous for obtaining inverted negatives for collotypes from ordinary negatives, either in the same size, or of enlarged or reduced dimensions.

I now proceed to give directions for preparing collodio-bromide dry plates, which are not only especially well adapted for the above purpose, but which, from their great purity, fineness of grain, and reliability, can also be used with advantage in many other cases. Their sensitiveness is slight, so that they require about six times as long an exposure as a wet plate. But this very circumstance adds to the convenience and certainty in working with them, as any dark room fit for the collodion process will serve in this case. A little experience shows that great sensitiveness is often a secondary consideration, and that, in many cases, some other special quality is of greater importance.

Collodion.—Zinc bromide, 5 grains, dissolved in 200 grammes alcohol, mixed with 5 grammes pyroxyline, and 200 grammes ether. When completely dissolved, let the solution settle for two or three days, and the collodion is ready for use.

Silver Bath.—Silver nitrate, 14 grammes, dissolved in 100 grammes water, and acidulated with a few drops of silver nitrate.

Developer.—Composed of the three following solutions:

A.—Crystals of ammonium bicarbonate 25 grammes, dissolved in 100 grammes of water.

B.—Potassium bromide, 10 grains in 100 grammes water.

C.—Pyrogallic acid, 10 grammes in 100 grammes water.

Preservative.—Equal parts of beer and water heated till the mixture ceases to froth, and filtered.

The above are the requisite materials. A polished glass plate is coated with the collodion, and silvered in the bath as in the usual way, and then well washed in water. After washing the plate is laid for a couple of minutes in a three per cent. solution of potassium bromide, and again washed in water. After this second washing the preservative is flowed over it twice, and the plate then placed in a vertical position to dry. The developing solution must be prepared just before using, by mixing 100 cub. centim. of the A (bicarbonate of ammonia) solution, 2 or 3 cub. centim. of the B (potassium bromide) solution, and 3 cub. centim. of the C (pyrogallic acid) solution. If the operator be in the habit of working with an iodized collodion, rich in bromide, he can use it for this process in conjunction with the ordinary silver bath; but after washing, the plate must be laid in a five per cent. solution of potassium bromide. The preservative and developer are employed as directed above, and good results will be obtained by this means.

* *Deutsche Photographen Zeitung.*

AN ELECTRICAL SPEECH-RECORDER.

A CURIOUS piece of apparatus, not likely to be of practical use, but showing considerable ingenuity, has been devised by M. Amadeo Gentilli, of Leipsic, for the purpose of giving an intelligible record of speech. The natural movements of the mouth in speaking are employed to produce through delicate levers a series of electric contacts, and thereby sundry combinations of signs on a moving band of paper, similar to those of the Morse alphabet. The transmitting portion of the apparatus is based on a careful study of the motion of lips and tongue in speaking with an object held between the teeth. The working parts are mainly arranged on an ebonite plate, from one end of which projects a piece to be taken between the teeth, whereupon the mouth-levers come into position. The nasal puff in sounding *m* and *n* affects a special delicate organ. There are eight electro-magnets in the receiver, each of which, when actuated by a current, causes a line to be formed on the paper. It is mentioned by M. Guerout (who describes the apparatus in *La Lumière Electrique*) that the letters *g* and *k*, *d* and *t*, *b* and *p*, *f*, *v*, and *w*, which are produced by movements very slightly different, are represented by the same signs. Thus of these letters the alphabet comprises only *g*, *t*, *b*, and *f*. Further, *c*, *z*, and *x* are represented by *ts* and *gs*. The apparatus will, perhaps, be shown at the forthcoming Exhibition in Paris.

THE ROMAN VILLA NEAR BRADING.

THE second edition of the "Guide to the Roman Villa, recently discovered at Morton, between Sandown and Brading, Isle of Wight," which has been drawn up by the excavators of the buildings, Messrs. John E. Price, F.S.A., and F. G. Hilton Price, F.G.S., contains an account of nineteen chambers which had been laid bare up to the time of its issue.

During the last few weeks these gentlemen have uncovered a dozen more chambers, making thirty-one in all. Of the twelve just brought to light two are of large size, one of them measuring 54 ft. by 22 ft. It had pillars on two sides to support the roof placed against the walls, as the discoverers found large blocks of stone and concrete which formed the foundations.

There were smaller chambers flanking on either side this very large one. Continuing due east, and joining the last named, is another room nearly 40 ft. long by 32 ft. broad; and on the south and east sides of it are more solid blocks of concrete at equal intervals. On the north side, at a distance of eight feet from the north wall, are three of these blocks, corresponding with those on the south side. Seemingly, this chamber was approached from the east through a vestibule, since at regular distances four more blocks occur which likewise correspond with those opposite. Comparatively few remains beyond roofing slabs, bits of pottery, and a quantity of bronze, consisting of a lock-plate and studs for the ornamentation of a chest, were discovered in these large chambers.

Another interesting feature which yet remains, however, to be worked out, is the appearance of a roadway.

Adjoining the wall of the last-mentioned chamber is a well-house, with two semicircular apses. The well itself has been sunk to a depth of 80 ft., and water has been found, still the bottom has not been reached as yet. In excavating it a large quantity of bones of the horse, ox, sheep, dog, and pig were met with, as well as fragments of pottery in masses and stones.

Southward of the supposed roadway, which runs by the side of the outer wall, is a large open space. From the fineness of the soil it is supposed to have been the garden, and upon its western side is the foundation of an alcove or hemicyclum.

An interesting chamber, nearly square, and resting on a solid foundation, has been discovered on Mrs. Munns' side of the site. This room yielded a bracelet in bronze, a fibula, and a considerable number of coins. These last range in date from Domitian (A.D. 81–96) to Valentinian (A.D. 383–392). Every effort, says the London *Times*, is now being made to bring about an amalgamation of the excavations which cover two separate freeholds, one belonging to Mrs. Munns and the other to Lady Oglander.

THE RUINS OF LIBYDIA.

CAPT. GEORGE S. PRATT, of the steamship Lady Lycett, during a recent trip to North Africa, visited the site of the ancient city of Libydia, which he found partly buried in a sea of sand. The captain says:

"This must have been a city of great splendor ages ago. Heaps of massive marble pillars of blue, white, and red, in all positions, are scattered about and beautifully carved round the top and base. There were also some very large pillars of granite in a good state of preservation showing a fine polish. Statues are lying about, some with their heads and other portions broken off.

"A part of the city walls are standing arched, and arched gateways or entrances to the city are also standing in three places, two sides and one top; others buried in the sand. There are many massive pillars of blue marble, say fifty feet long, and having a circumference of eighteen feet, lying washed by the sea—for a portion of the city is under the sea. On the south side of the city was evidently the port and river, but which is now transformed into a valley the entrance to which has grown up level with the seashore. One immense portion of a fortress has broken in two and fallen into the valley or ancient port.

"There appears to be an outer town with old ruins of a fortress which, I suppose, was to protect the port. The fortresses are mostly built of red tile or brick, six inches square, a specimen of which I have on board. This outer town has on the south side of the river arched vaults resembling catacombs, where the dead were buried. The ancient people who inhabited this city appear to have made their coffins of strong earthenware of red color. The sea having washed up to them and broken them, the bones are to be seen inside.

"This must have been a cemetery, the more wealthy class being buried in the catacombs.

"I once visited some ancient catacombs, and I am convinced that the living relatives of the dead dwelt in them. The stones with which they ground their grain for food and hearths where they cooked were still visible.

"Tradition states that people sometimes went into the catacombs, wandered about until they were lost and were never afterward seen. I noticed air shafts for ventilation, and places cut out where the dead were laid and where the wanderers burnt their oil for light.

"On the top of two mountains, north and south of the city, are ancient ruins of forts which were placed there to protect the city of Libydia from inland invasion.

"In conversation with an Arab, he said:

"'I ride for hours on horseback, and see neither man nor habitation; those we do see are great robbers.'

"This country once contested with Rome for the power of the world. The whole country possesses all the advantages of soil and climate that man needs desire. The soil will yield most bountifully if tilled. Mohammedism in its uttermost degree of personal indulgence and wantonness of power, restrains all rational and social advancements.

"The inhabitants are in poverty and ignorance, and it is not safe to go out of the town unarmed. The sand in the ruins of Libydia is full of marine shells, so it must have been destroyed by an earthquake, the sea overrunning the city and receding back, leaving the deposit of sand and shells. No warfare could have scattered those immense pillars of marble in the directions they now lie.

THE NIOBRARA GROUP.

By CHAS. H. STERNBERG.

THE rocks of Cretaceous No. 3, or Niobrara Group, consist of an upper stratum of red, yellow, or white chalk, underlaid by great beds of blue shale. There is no paleontological difference between the strata, as the same animal remains are found in both. These beds are of great value to science, as they contain the remains of animals that once inhabited the cretaceous ocean. Perfect skeletons are found of huge saurians eighty feet in length. What a field for the imagination of the student, to people the old cretacious seas with animals restored from their buried relics! I now in imagination walk the old cretaceous beach; I hear the rush of mighty rivers, as, laden with the *débris* of the carboniferous hills, they pour into the ocean, depositing their loads of soft mud that is to cover and preserve the remains of animals living in these waters. Far out at sea, I "observe a huge snake-like animal, with head erect, full twenty feet in air, gazing into the depths below." The fish that meets his eye will soon fall a victim to his voracious appetite. Another monster of the deep grandly exposes a length of eighty feet; as he lies stretched on the waters an enemy in the distance attracts his attention and he prepares to offer battle; his four powerful paddles begin to work, and that vast mass of animal life commences slowly to move; gradually it gains more speed as the paddles move more rapidly; his huge tail, acting like a screw propeller of some steamboat, augments his speed and guides him toward his prey. The water boils behind him. It matters not how large the animal may be that he means to attack, if once it receives a stroke from the powerful bony snout of our saurian (for he means to use it as a battering ram), it will lie a crushed and helpless mass upon the surface and the bubbling waters will suck it in; on the bottom of the ocean it will be dragged hither and thither by sharks and other rapacious fishes which will have many a dainty feast from its body. The soft mud of the ocean's bed will at last cover and bury the skeleton and preserve it for ages; future explorers will gather up and admire the finely marked bones for the attachment of muscles. A fleet of smaller saurians heave in sight; they twine their long delicate necks together or dive beneath the surface for some luckless fish, which, on again appearing, they hold in their long glistening teeth. "The air is darkened by great flying saurians that flap their leathery wings over the deep," or dive in pursuit of prey. As evening approaches they flock to the shore and suspend themselves by their claw-armed fingers to the cliffs. Wandering along the shore, I find that a huge fish, twenty feet in length, has become entangled in the shifting sands of a shallow bay. It seems to be in agony, and, seeking the cause, I find it has been pierced by the long bony snout of some smaller fish that uses this weapon as the sword-fish of modern oceans does his sword. The beach is strewn with large oyster-like shells, twenty-seven inches in diameter. "They seem to be the remains of a feast of some titanic race."

As the explorer approaches the beds of the Niobrara Group, he often sees in the distance a city of imposing grandeur. Wide streets, lined with buildings of dazzling whiteness, meet his eye, and only a near approach will convince him that he is looking at nature's handiwork. The rains of ages have cut and fashioned the soft limestone into the semblance of cities. The shale beds of this formation contain great quantities of the salts of soda and magnesia, and the waters flowing from or through these beds are strongly impregnated with "alkali." They also contain iron pyrites and gypsum. I have often, while wandering along some wash (where the chalk and shale have been denuded), found some fossil bones scattered along, and by following them up to where bones project from bluff or bank, I find I have stumbled upon the burial ground of a denizen of the ancient cretaceous seas. Perhaps it is a species of *Leiodon* and reaches a length of eighty feet. Its long teeth glisten in the sunlight, and its powerful paddles reach far in the bluffs on either side, requiring days of toil to lay them bare. The great bony snout (the characteristic of all his race), which, with other peculiarities, places him in Cope's new suborder of *Pythonomorpha*, lies pointing beavenward. I find that he is without an expansible gullet, as in modern serpents; another method of swallowing his food whole is given him, as without it he could not exist, as he has no teeth for masticating, and I find that the jaws are provided with a set of hinges, of ball and socket pattern, just back of the dentary bone. He is thus enabled to expand the cavity of the mouth. All now that was necessary to allow the passage of large morsels into the stomach, was a loose, baggy, pelican like throat, with which he was doubtless provided. His teeth were long and conical, slightly recurved; his head long and conical, with eyes directed upward. He, perhaps, had the faculty of flattening his head like the python. One peculiarity of the order is found in the quadrate bones, which not only places him in the rank of reptiles, but enables the student to distinguish from it the different species. In shape this bone resembles the external ear of a man, and is composed of the bones that help make up the internal ear in mammals. This bone connects the under jaw with the skull and allows all the motion necessary. His tongue was long

and forked, like a serpent's, and was thurst out while in motion. The only noise he could make was a hissing sound. While at rest, "the tongue was concealed in a sack under the windpipe." *Leiodon proriger*, Cope, reached a length of eighty feet; it had a long slender neck, twenty feet in length; the tail was long and powerful, and was doubtless used both as a rudder and propeller. *Clidastes tortor* was an elegant creature, about forty feet in length; its vertebral column was provided with an additional set of articulations, so as to enable it to coil itself like a snake; this seems to be its favorite position, as I have often found it thus coiled.

Clidastes pumilus, Marsh, was a little creature, ten or fifteen feet long, and doubtless often fell a victim to the larger saurians or rapacious fishes with which the cretaceous seas abounded. The Pterodactyls of the Niobrara differed very much from those of Europe; they were much larger; I have found them with an expanse of wing of twenty-five feet; they were also without teeth, and Marsh has made the new genus *Pteradon* for them. One peculiarity of the Niobrara Group is the presence of the only known birds armed with teeth.

Ichthyornis dispar, Marsh, was a bird six feet in height; it was armed with long sharp teeth; the wings were poorly developed; they were swimmers and lived on fishes. Other birds are found no larger than a dove; they are arranged in families according to the position of the teeth, which are placed either in grooves or sockets. Believers in the evolution theory have received the discoveries of reptile-like birds as a positive proof that they have descended from reptiles. Of all the strange animal forms found in the rich fossiliferous beds of Western Kansas, I think Cope's *Protostega gigas*, or marine tortoise, is the most unique. Cope calls them the boatmen of the cretaceous ocean.

In 1877 I discovered a specimen that measured twenty feet from one flipper to the other; the distance between the condyles of the lower jaws was eighteen inches. We know that in modern turtles the young, when first hatched, have free ribs like other animals, and that in process of growth, bone is deposited in the skin, the ribs expand and unite in connection with the breastbone, forming a perfect shell or house. This is not the case in *Protostega;* in the adult the ribs are free, and, in place of a shell, these animals are provided with great dermal plates, two feet in diameter, an inch thick in the center and beveled off to a thin figured margin. When Prof. Cope discovered this animal, he was confident he had found a young turtle, but it was impossible to believe that an animal measuring twenty feet from flipper to flipper had just been hatched, and on studying the bones he was forced to conclude that it was a full grown animal, and to be one of those miniature types that is often found in the geological strata—another fact taken by many to prove that animals of the present day have been derived from more imperfect species, which, by process of growth, have obtained the perfect condition in which we find them.

Great oyster like shells are found in the Niobrara called by Conrad, *Haploscapha*. They often measure twenty-seven inches in diameter and are usually covered with small oyster shells, *Ostrea congesta*. Among fishes the first resembling our common edible species are found. The species that leads them all in point of size and ferocity is Cope's *Portheus*.

P. molossus was twenty feet in length. It was provided with a huge bulldog shaped head with fangs projecting from the mouth four inches. The roof of the mouth and lower jaws were covered with teeth irregular in size—some long and conical as the ones mentioned; others much shorter. These huge fishes were also provided with other means of defense or attack in the shape of great bony spines, with one edge enameled, that, even in their fossilized forms, are hard and sharp enough to be used in cutting wood. In some species one edge is toothed. They are often three feet in length and are made up of bundles of rods which terminate in the sharp teeth of some species, or are beveled down to make the sharp edges of others. I have no doubt but that these enormous fishes would not hesitate to attack their neighbors the saurians. They were certainly well provided with weapons, for, in addition to the ones mentioned, their tails were forked and made up of bundles of hard bony rods, and, I imagine, a blow from this would disable an antagonist easily. Another peculiar species found in Western Kansas is the snout fish, or Cope's *Erioiethes*. Though small, not over five or six feet in length, its bony snout, six or eight inches in length, must have proved a terrible weapon. I discovered three new species of this genus in 1877. We have also the *Enchodus*, a fish with teeth, one on each premaxilla, that were shaped like the incisors of a beaver. Sharks abounded; I have often found their flat coin-like vertebræ and delicate serrate edged teeth. One species of this family are provided with teeth covering the roof and floor of the mouth, which were doubtless used as a mill for grinding up food. Some beautiful crinoids were found by Prof. Mudge's party in the rocks of this formation. A company has been organized at Trego Kan., for the purpose of utilizing the chalk by making waterproof cement—said to be equal to the best Portland cement. Great quantities of iron pyrites and gypsum are found. The rocks are of little value for building purposes, although it has been used in making the buildings at Fort Wallace, with the belief that they would harden when exposed to the atmosphere, but they are as soft now as when the buildings were first made. Near Wallace, however, builders can draw from the conglomerates of the Loup Fork Group, which are found on the high lands near by.

I am greatly indebted to Prof. E D. Cope's Cretaceous Fauna, from which I have drawn largely in the preparation of this paper, as I could obtain many facts from no other source. I hope he will pardon the use of some of his descriptions.—*Kansas City Review.*

THE GEOLOGY OF FLORIDA.

PROF. E. A. SMITH, of Alabama, traces the geological history of the peninsula of Florida as follows:

(1.) Since no rocks have been found in Florida older than the Vicksburg limestone, it follows that, until the end of the Eocene period, this part of our country had not yet been added to the firm land of the continent, but was still submerged.

(2.) During the period of disturbance which followed the deposition of the Vicksburg limestone, Florida was elevated nearly to its present height above the sea-level, which elevation was maintained without material interruption until the Champlain period.

(3.) In this upward movement the axis of elevation did not coincide with the present main dividing ridge of the peninsula, but lay considerably to the westward, probably occupying the position very nearly of the western coast of to-day.

(4.) After the Miocene (or possibly the Pliocene) period, there was again an elevation of Florida, as is shown by the presence of a Miocene limestone on the eastern slope of the peninsula, some distance (not less than thirty feet) above present sea-level.

(5.) We have evidence in the distribution of the beds of the Champlain period (stratified drift, or orange sand) that Florida and parts of the adjacent States were during this time submerged sufficiently to allow the deposition over them of a mass of pebbles, sand, and clay, varying in thickness from a few feet to two hundred.

From the peculiar mode of stratification of most of these beds, it is concluded, with reason, that they were sediments from rapidly-flowing, ever-varying currents. In the northern part of the State, the beds of yellow and red loam lie directly upon the stratified drift. These beds of loam are devoid of stratified structure as well as of fossils, and were probably deposited from slowly running or nearly stagnant waters.

(6.) Following the submergence during the Champlain period was a re-elevation, which brought up the peninsula with approximately its present configuration.

FRUIT SIRUPS.*

By ADOLPH G. VOGELER, Ph.G., Chicago.

ALREADY largely prescribed by practitioners in the United States, sirup of raspberry constitutes a most pleasant addition to many medicines, especially those containing mineral acids. In many compounds it cannot be advantageously replaced by any other corrective, owing to its agreeable aroma. This sirup is particularly adapted for saline antifebrile mixtures, or for potions otherwise insipid, as for instance solutions of pepsin, lactopeptin, etc., while it is also desirable for preparing cooling draughts for the patient.

Strawberries, mulberries, and black cherries may be mentioned as yielding palatable sirups, but in no wise equal to that of raspberries.

The preparation of the sirup may be accomplished in two ways: either the juice is expressed from the fruit and then combined with sugar; or the unimpaired berries are mixed with sugar, when the latter will extract the juice, leaving the berry shriveled and tasteless. Owing to the circumstance that practically but two months would have been at my disposal for comparative experiments, I refrained from endeavoring to determine the most preferable method of making fruit sirups (two years would be short allowance for such a purpose), and shall for that reason only enumerate various methods as compiled from different sources. I wish to remark, however, that I should give preference to the process as exemplified by the German Pharmacopœia, modified by an addition of five per cent. of alcohol to the contused berries previous to fermentation (process No. 2). Pectin in this manner will separate more rapidly, while the juice is less liable to deteriorate. It may be found best to direct the pure filtered juice to be preserved by means of Appert's process, and to have the sirup prepared for this in small quantities for actual use only. The raspberry sirup as found in the market is quite a thin fluid, keeping indefinitely, from which I infer that it contains an appreciable amount of alcohol. According to my personal experience fruit sirups will undergo fermentation if exposed in shelf-bottles; if then the presence of a specified percentage of alcohol will preserve the same, I can see no valid objection to its introduction. Before proceeding to enumerate the different processes for making fruit sirups or juices, a test for distinguishing natural sirup of raspberry from a spurious article may not be out of order. I copy from "Handbuch der Pharmaceutischen Praxis," ii., pp. 830, 831.

Test for Sirup of Raspberry.—a. Mix equal volumes of the sirup and of ammonia 10 per cent. The color of true sirup changes to violet with a slight tinge of green. If, however, the color changes instantly or soon to green or yellow, some foreign vegetable coloring matter is present; and if it should become colorless or nearly so, it is adulterated with rosaniline.

b. If the sirup is colored with red aniline the latter may be detected by macerating it in some white silk or wool, and rinsing the cloth in water. Water removes the raspberry stain, but not the aniline. If the fabric be dipped in ammonia the aniline dye will vanish, but reappear on moistening with acetic acid.

Sirup of Raspberry.—1. Contuse the berries, place them in a vat, add 2 per cent. of sugar, and ferment the mass at a temperature of between 70° and 80° F. for three or four days until all pectin has separated and no more signs of fermentation are visible. Then express the juice, which allow to settle in a cool place for two days, decant carefully from the pulverulent pectin, and filter. Preserve the juice by Appert's process (see the *Druggists Circular*, 1878, p. 61), or convert into sirup by dissolving in 5 parts of the clarified juice 9 parts of sugar, and heating to the boiling-point.—"Handb. d. Pharm. Praxis," i., p. 796.

2. A better and safer way is to add at once to the freshly bruised fruit 5 to 6 per cent. of alcohol, and then proceed as in the foregoing. This formula would seem to deserve preference.—*D. C.*, 1880, p. 99.

3. Crush the raspberries in a glass vessel with a wooden pestle to a pulp, add to it 5 to 10 per cent. of cane or grape sugar, and allow the whole to stand, stirring occasionally. When the mass ferments the juice becomes clear; it may then be filtered and bottled, or converted into sirup.—*D. C.*, 1873, p. 130.

4. Put 6 pounds of raspberries into a china bowl, with a quart of water in which has been dissolved 2½ ounces of citric acid, and let it remain twenty-four hours; then strain, taking care not to bruise the fruit. To each pint of clear liquid add 1½ pounds of sugar, and stir until it is dissolved.—*D. C.*, 1872, p. 128.

5. Proceed as in No. 1. When the fermentation is nearly ended (indicated by the appearance of a small yellow fly) express the juice, add to every pound of the latter 1 ounce of deodorized alcohol, set aside for one night, and then filter. Bottle the juice, or convert into sirup.—*D. C.*, 1878, p. 109.

6. Macerate the berries in layers interspersed with sugar, 1¾ pounds of sugar to 1 pound of berries, for twenty-four hours in a cool cellar, and then drain off the juice. Preserve the sirup by means of Appert's process.—Parrish's "Pharmacy," p. 264.

7. Add to the foregoing product some alcohol, or a little bisulphite of lime. The flavor is not supposed to be impaired by the latter.—*D. C.*, 1870, p. 43.

8. Pure fruit juice, 16 fluid ounces; dilute acetic acid, 1 fluid ounce; water, 7 fluid ounces; granulated sugar, 3 pounds. Dissolve the sugar without heat. Preserve in air-tight vessels in a cool place. The acetic acid is objectionable.—*D. C.*, 1874, p. 208.

Sirup of Mulberry.—Mulberry juice, 1 pint imp.; sugar, 2 pounds; rect. spirit, 2½ fluid ounces. Heat the juice to the boiling-point, and when it has cooled filter it. Dissolve the sugar in the filtered liquid with a gentle heat, and add the spirit.—B. P.

Sirup of Strawberry.—Put 2 parts of strawberries deprived of the calyx, without crushing them, into a large-mouthed jar; add to them 2½ parts of sugar, and frequently shake, keeping the vessel in a cool place. The sugar absorbs the juice, leaving the fruit shriveled and tasteless, the latter being removed by means of a strainer without pressure. Mix the clear sirup with 20 per cent. of alcohol. (Source some German journal.) I have made sirups of strawberry and of pineapple in this way for soda-water, not adding any alcohol, but I bottled it as soon as made. These sirups were excellent, and I have kept some of them for three years without change, only that a slight sediment would form, which was easily separated. But this sirup will spoil as soon as exposed to the air, except when kept on ice. The above addition of alcohol overcomes this defect.

Sirup of Cherry.—Employ the black, sour variety. Crush the cherries, together with the stones, and follow the directions given in No. 2.

Fruit Sirup for Lemonade.—Raspberries, 1,000 grammes; blackberries, 500; bilberries, 500; lemon, 3 fruits. Mash in a stone mortar, and add of cold water, 1,500. Let stand for three days, or until fermentation has finished. Express and filter. In every 2,500 dissolve citric acid, 40; and sugar, 4,500. Boil up once in a copper kettle.—"Handb. d. Pharm. Praxis," ii., p. 831.

* From a paper read before the American Pharmaceutical Association. From the "Transactions."

ARE WE RIGHT SIGHTED?

IN the number of the *Medical Record* for March 19, the following experiment, made by the editor of the *Louisville Medical News*, is given:

"As you sit in your chair, point to any object across the room with both eyes open and no attempt at 'sighting.' Close the left eye and you will find you are still accurately on the object, but close the right eye and you will discover with your present vision you are pointing clear over to the right, provided you are right handed."

In trying this, the finger or pencil appears double that is used to point at the object. In the case where the right eye sights, the direct or true pointer is to the left. The one to the right is seen by the left eye and is off the mark. This is reversed when the left eye does the work.

From such experiments it has been asserted that binocular vision does not exist.

Any one who has any doubts on the subject of binocular vision can be convinced by experimenting fifteen minutes with a stereoscope, provided he does not squint and has fair vision in each eye.

Although we have binocular vision, it does not of necessity follow that both eyes do an alike amount of work. That we use one eye for sighting, pointing out the direction of any given object, any one can prove for himself; but to prove the unequal use of our eyes is more difficult.

Three years ago, while assisting Dr. H. D. Noyes, I went over with care the records of more than a thousand of his private patients where each eye had been carefully examined and the vision and refraction noted. The general results were as follows: When myopia existed there was a higher degree in the right than in the left eye.

When hyperopia was present there was a less degree in the right than in the left eye, and, *cæteris paribus*, the hyperopia became sooner manifest in the right than in the left eye.

In the hyperopic cases the vision was more acute in the right than in the left eye. In the myopic cases, the vision was almost the same in each eye, taking all degrees into consideration.

In other words, of all the eyes examined, the right was longer in antero-posterior diameter than the left eye, the increase in length being caused by the extra work done by the eye.

The better vision found in the right eye of the hyperopic cases means more use and a higher development. A highly hyperopic eye is an undeveloped one and not best suited for the requirements of our modern civilization. On the other hand, myopia is an outcome of civilization and is a disease due to abuse—overwork. To draw positive conclusions from the examination of two thousand odd eyes, is, to say the least, unscientific.

The inference is, that with binocular vision we use one eye more than its fellow—that one being generally the right eye.—*Peter N. Callan, in Medical Record, New York.*

SAW PALMETTO.

(*Sabel Serratula.*)

WHERE a highly nutritive agent is needed, saw palmetto is indicated. By its peculiar soothing power on the mucous membrane, it induces sleep, relieves the most troublesome cough, promotes expectoration, improves digestion, and increases fat, flesh, and strength. Its sedative and diuretic properties are remarkable. It has been used with benefit in cardiac asthma, phthisis (especially laryngeal phthisis), chronic bronchitis, and dilatation of the bronchial tubes. Its action in catarrhal affections is rapid and permanent. A cold in the head may be abated by two or three doses. Mixed in boiling water and used by inhalation, it has been found very beneficial in chronic ozena. Several years ago, while on a hunting trip in the wilds of Florida, Dr. J. B. Read had his attention drawn to the great fattening properties of the berries and the peculiar quality of the fat of the animals that feed on them. During the summer months in those parts, the supply of food is scanty for such animals as bears, raccoons, opossums, and hogs, and they consequently become very thin. As soon, however, as the palmetto berries begin to ripen, they improve rapidly, and in a few weeks have acquired an enormous quantity of fat, and they become unwieldy and an easy prey to the hunters. This fat, like that of most eating animals, consists principally of olein, and will not make lard. The berries, when dropped into the water, are seized and eaten with avidity by the fishes, and even the natives frequently acquire a taste for the berries and eat them freely.—*Jour. of Mat. Med.*

THE IMPURITIES IN WATER, AND THEIR INFLUENCE UPON ITS DOMESTIC UTILITY.*

By George Stillingfleet Johnson, M.R.C.S., F.C.S.

There are some impurities found in the water of rivers, more especially in those rivers which, like that in the immediate neighborhood of this building, take their course through large towns, concerning which I shall have little to say this evening. I allude to organic impurities, the detritus of living beings, sewage, and the like, and my reason for keeping silence upon this great subject is the incompleteness of our knowledge regarding it. Our highest medical authorities seem to be at variance as to the nature and degree of the baneful influence exerted by those impurities which I have mentioned upon the human economy, with the exception of the so-called specific poisonous products of such diseases as typhoid and cholera; and our highest chemical authorities are very much at variance as to the best method of estimating or determining the amount of these organic pollutions in waters, as they also are in the various accounts they give of the processes by which nature removes them. It would ill become me, therefore, to do more than hint at the existence of this source of contamination of water, unless I stood prepared to bring forward some new facts or experiments throwing light upon the subject, which I am not in a position to do. I must, therefore, confine myself this evening to the discussion of some of the more important inorganic impurities contained in natural waters, and their influence upon the domestic utility of the important liquid which contains them.

The word "impurities" has occurred several times already in this paper. I have also spoken of "pollutions" and "contaminations," all of which expressions tend to convey the idea that the presence of substances so described in the water we drink and employ for household purposes generally, must needs be injurious and prejudicial. Now, the tendency of this paper will rather be to show the great usefulness of many of these so-called "impurities" in natural waters; and the word is used here in its strictly chemical sense, to indicate anything which we find in and accompanying water which is not the chemical compound H_2O.

Pure water, the compound containing two atoms of hydrogen combined with one atom of oxygen, is a pure chemical substance which is never found in nature. We explain this by the statement that water exerts a solvent action upon various gases and solids.

It is, then, by virtue of its solvent action that water becomes impregnated with the impurities of which I am to speak; and I will, therefore, ask you to follow me while I make a few preliminary remarks upon, and show you a few experiments illustrating, the nature of solution. The process of solution consists essentially in a change of physical state, without alteration of chemical constitution. Thus, when sugar or common salt is dissolved in water, we can obtain the solid sugar or chloride of sodium by simply evaporating the water; and these are instances of true solution; but, if metallic copper be dissolved in nitric acid, that is an instance of solution accompanied by chemical change; for, if we evaporate the blue liquid thus obtained, we have a deposition, not of metallic copper, but of nitrate of copper, the salt formed by the chemical action which takes place between that metal and nitric acid. Solution proper, then, consists in a change of physical state simply without change of chemical constitution. Now, we know of but three physical states in which matter can exist, the solid, the liquid, and gaseous. The solvent or substance which brings other substances into solution is usually a liquid. The dissolved body may be either a solid or a gas.

Now, the physical state in which we find any substance depends to a great extent upon the nature and intensity of the physical forces which happen to be acting upon it at the time. Besides the action of solvents, the two physical forces, heat and pressure, exert a powerful influence upon the physical state of matter. The essential difference between the three physical states of matter is one of the relative freedom of motion which exists between the molecules or ultimate particles of which the matter consists, the gaseous form of matter possessing the greatest, while the solid possesses the smallest, degree of molecular mobility. Heat, on the one hand, increases this mobility of the molecules of matter, while pressure has the reverse effect.

Next, observe that the solvent (liquid water, *e. g.*) is in the intermediate condition, as regards molecular mobility, between the solid and the gas, whose physical state it must assimilate with its own before it can bring them into solution. It follows, then, that the liquid solvent must bind a gas in chains, as it were, must diminish the free mobility which exists among the particles of that most elastic form of matter, while it will have to increase the molecular mobility of the comparatively sluggish solid, in order to make them respectively assume its own physical state. Accordingly, we should expect to find that a liquid will have its solvent action upon solids increased by the application of heat, while its power of dissolving gases will be diminished by heat, but improved by pressure. And these laws are obeyed in almost all instances.

I will now show you one or two experiments, to illustrate these preliminary remarks upon solution. When I stir up these two white powders in separate beakers of hot distilled water, you observe that one of them (which is powdered sugar) becomes readily incorporated with the water, changes its physical state, assuming that of its solvent, is dissolved. That is an instance of a soluble substance. This other powder, however, refuses to do anything but remain partially suspended in the water, making the liquid look milky, while the greater part of it (for it is very heavy) sinks and remains at the bottom of the beaker. It is the salt called sulphate of baryta, and is one of the most insoluble bodies known.

To illustrate the effect of heat in assisting the solution of a soluble solid substance in a liquid, it will be sufficient to cool this hot saturated solution of iodide of lead, when we find that water, which was capable of retaining a large quantity of that salt in the liquid state while hot, becomes incapable of doing so as it cools, and the excess of salt separates out from the solution in the crystalline form.

To demonstrate the action of heat in retarding the solution of a gas in a liquid, I will first pass up a little water into this tube (which contains dry ammonia gas confined over mercury). As soon as the water reaches the gas, you see that the latter disappears, being dissolved by the water. Now, if I pour a little hot water over the outside of the tube, we shall soon see the effect of heat in increasing the molecular mobility of the ammonia, for the restraining power of the water, at this high temperature, becomes insufficient to control the elasticity of its volatile companion, and the ammonia bursts its chain and resumes the gaseous condition. As the tube cools again, the solvent power of the water is again triumphant, and the gas disappears. Not only does the temperature of the liquid solvent exert an influence upon the quantity and quality of the substances which it is capable of dissolving; but the solvent action of a liquid is often considerably modified by the presence therein of substances which it has already dissolved.

We will consider this influence of dissolved matter in water upon its solvent action on other forms of matter somewhat fully, since it serves to explain the presence of some of the impurities found in waters; and it will be convenient to divide the subject into two heads, viz.:

1. The influence of dissolved gases upon the solubility of solids.

2. The influence of dissolved solids upon the solubility of other solids.

1. Excluding those cases in which a chemical action occurs, resulting in the production of some insoluble compound by the action of a dissolved gas upon one or the other of the elements present in a dissolved solid, the general tendency is for a dissolved gas to increase the solubility of solids in their common solvent. As an illustration of this, I will cover this solution of copper of sulphate with a strong solution of ammonia gas in water. You see now three layers in the containing vessel. Below the blue solution of copper sulphate, above the colorless solution of ammonia gas in water, and between the two, a light blue turbid layer, the turbidity of which is due to the presence there of suspended hydrated oxide of copper, a substance which is insoluble in pure water, and in most neutral and alkaline solutions, but which is soluble in a solution of ammonia gas in water, yielding a dark blue liquid, which you see is produced when I stir up the contents of the beaker. There are other instances which will occur to every chemist, of solid bodies quite insoluble in pure water, yielding to the solvent action of a solution of ammonia gas in water. It appears, then, that the dissolved gas confers a degree of molecular mobility upon the water which has dissolved it, or at least enables that water to produce the requisite freedom of motion among the molecules of an otherwise sluggish solid, which is necessary in order to compel it to assume the liquid state.

2. It is frequently observed, and especially among the halogen group of elements, that an insoluble salt is rendered soluble by the presence in their common solvent of a very soluble solid body. One of the most striking and beautiful examples of this is seen in the case of the red mercuric iodide, which is entirely insoluble in pure water, but is readily dissolved by water saturated with potassic iodide—a very soluble salt. It is essential that the potassic iodide be present in a somewhat concentrated solution, for, as you see in this beaker, when a solution of mercuric iodide in one of potassic iodide is mixed with a large bulk of pure water, the red mercuric iodide separates out. If there be any chemical action between the two iodides in this case, it is of the very feeblest kind. Indeed, some experiments of my colleague, Mr. J. M. Thomson, have tended to show that, if the double salts formed by dissolving insoluble halogen compounds in soluble ones be compounds at all, they are molecular, not atomic combinations. It is, at all events, interesting to remark, that when a dissolved solid assists the solution of another solid body, it is the more soluble substance—that which is endowed with freest molecular mobility—which serves to bring about the liquefaction of the more sluggish solid; and there are instances of this action which cannot be at all explained by chemical action, as in the case of the solubility of quicklime in a strong solution of sugar.

It sometimes happens that the action of a solvent is arrested, by the formation of a protecting film of an insoluble substance upon the surface of an immersed solid. Thus, marble, which is a compact crystalline variety of carbonate of lime, is freely dissolved by a solution of hydrochloric acid gas in water, the only solid product of the accompanying chemical action being the salt known as calcic chloride. Now, calcic chloride is freely dissolved by water, and, as each particle of it is formed on the surface of the marble, it is dissolved off by the water, and fresh surfaces of marble are constantly exposed to the action of the hydrochloric acid. But, if we immerse marble in water containing both hydrochloric acid and sulphuric acid in solution, its surface speedily becomes covered with an insoluble film of calcic sulphate, and the action ceases. Marble is still there in abundance; hydrochloric acid is also present in quantity, adequate and sufficient for its solution; but, by reason of the intervening insoluble film of calcic sulphate, they are prevented from acting upon one another. "The chemical force can only act at infinitesimally small distances." Another instance of the protecting action of an insoluble film upon the surface of an otherwise soluble solid is seen in the case of the black ferrous sulphide. When this substance is acted upon by sulphuric acid, the salt known as ferrous sulphate is produced. Now, green vitriol, or ferrous sulphate does not dissolve in cold, strong sulphuric acid, but it dissolves readily in hot dilute sulphuric acid. When, therefore, I pour cold oil of vitriol over this ferrous sulphide, there is little or no action, a film of ferrous sulphate forming on the surface of the sulphide, and protecting the sulphide beneath from the action of the acid; but when I pour water into the containing vessel, a brisk action is at once set up, heat being developed by the admixture of the water with the acid, cold strong sulphuric acid being converted into hot dilute sulphuric acid, which dissolves off the ferrous sulphate as fast as it is formed.

I will now pass on to a consideration of some of the impurities contained in natural waters—in water as it is supplied to us for use in every-day life—explaining, where that is possible, the sources and method of contamination, and, further, discussing the chief precautions necessary for the removal of such impurities as are prejudicial to the domestic utility of this valuable agent. First, then, we will consider the gas found in solution in natural waters. With some trifling exceptions, viz., some of the rarer mineral waters, the gases dissolved in water are those which are present in our atmosphere—oxygen, nitrogen, carbonic acid, and ammonia. The oxygen and nitrogen gases, the elementary constituents of the atmosphere, are present in it in invariable quantities, and are far less soluble than the other two.

The carbonic acid and ammonia, or compound gases, are chiefly products of animal life, and are constantly being removed by plants and vegetable organisms, but they are also more soluble in water than the first two. The carbonic acid is present in larger proportion than the ammonia, while it is also far less soluble than the latter gas. Indeed, after a long continued fall of rain, the presence of ammonia in the air of a place is hardly recognizable.

Spring-waters are very apt to contain much larger quantities of CO_2 than rain water or river water. Meandering, as they frequently do, through subterranean passages, they are exposed in their course to influences peculiarly favorable to their conversion into strong solutions of this gas. The earth being the common receptacle for dead organic matter, and her cavities being in many cases never penetrated by the sun's rays, or ventilated in any way, accumulations of carbonic acid are to be expected in these regions. The water, then, which is often very cold (it may be produced by melted snows), is churned up at frequent intervals along its course with these terrestrial gases, and becomes, in consequence, highly charged with them.

We are able to demonstrate the presence of dissolved gases in water, by simply boiling it in an apparatus such as this which I now show you, and collecting the permanent gas which escapes, as is being done here. The presence of these dissolved gases in water appears to be in every way beneficial. If we consider water as a beverage, the sparkling and refreshing effect of spring-water is largely due to the dissolved gas, especially to the carbonic acid gas which it contains. Again, boiled or distilled water, from which the gases have been expelled by heat, is mawkish and insipid, but may be again rendered palatable by aerating it with charcoal. But more than this, absolutely gas-free water (which, however, can only be obtained by boiling water in vacuo) boils at a temperature considerably above 100° C., and with violent explosion.

Again, it is probable that the oxygen dissolved in water oxidizes, and removes some of the more readily putrescible organic matters contained therein; and it certainly is of the utmost importance to the life of fish. The dissolved gases in water also exert an important influence upon its solvent action for solids, as we shall now find. The solid substances dissolved in waters are generally chlorides, sulphates, and carbonates of the alkalies, and of the alkaline earth metals.

Those waters which contain the alkaline earths in solution, are divided into (1) calcareous and (2) magnesian waters, the former containing sulphate or carbonate of lime in solution, the latter sulphate or carbonate of magnesia. Such waters are said to be hard. Now, it is in the case of the carbonated calcareous and magnesian waters that we observe most distinctly the influence which a dissolved gas may exert in modifying the solubility of a solid in their common solvent. For the carbonates of lime and magnesia are insoluble in pure water, or nearly so; but considerable quantities of these salts may be brought into solution by water charged with carbonic acid gas. For instance, if I bubble carbonic acid gas through this clear lime water, we first observe a milkiness, due to formation of the insoluble carbonate of lime; and on continuing to pass the gas, we finally obtain a clear solution. The dissolved gas enables the water to overcome the molecular sluggishness of the calcic carbonate, and to reduce it to the liquid condition; just as the dissolved ammonia gas in our previous experiment enabled the water to hold in solution the hydrated cupric oxide. Now, if I boil this clear solution of bicarbonate of lime, the excess of gas is expelled by the heat (just as the ammonia gas was expelled from its dissolving water when the temperature of the tube containing the solution was raised), and the water, no longer aided by the mobile carbonic acid gas, loses its power of keeping the calcic carbonate in the liquid state; accordingly that salt is reprecipitated.

Bearing the facts in mind, we shall be able to explain some of the phenomena of nature in connection with this subject of calcareous waters. We have seen that spring waters are frequently highly charged with the carbonic acid gas; now carbonate of lime, in the shape of chalk deposits and limestones of various kinds, is a very constant ingredient of the soil in many parts of the earth's surface. It must, therefore, be a matter of very frequent occurrence for water, already highly charged with carbonic acid gas, to come in contact with carbonate of lime in the course of its subterranean wanderings; hence the frequent contamination of natural waters with dissolved carbonate of lime. But there is another interesting and very beautiful phenomenon which we are enabled to explain by the light of the above facts. I mean the formation of stalactites and formations such as are figured in the diagram on the wall. Suppose a water holding in solution much carbonate of lime and carbonic acid gas to trickle slowly through the roof of a cave. From each drop of water, as soon as it finds itself exposed to the common air, some of its dissolved carbonic acid gas will begin to evaporate, and for each molecule of gas which thus leaves the water, a molecule of calcic carbonate will be deposited in the solid form. Let a few of these solid particles adhere to the roof of a cavern, and from the nucleus thus formed, the production of vast conical masses, such as are here portrayed with their beautiful tapering apices pointing toward the earth, is only a matter of time. The nature and quantity of the dissolved salts in spring water will, of course, vary with the composition of the soil through which it has passed. Many mineral waters are of great medicinal value.

We will next consider the influence of dissolved lime salts upon the domestic utility of water. Is "hardness" in water prejudicial? If we consider the water as a beverage, the answer would be, No. The worst that hard waters have been accused of is that they produce a tendency to calculous formations in those who drink them. But I think the water-drinker may answer to the charge, "Not proven." And, on the other hand, we cannot but remember that the metals calcium and magnesium, in combination with phosphoric and carbonic acids, play the important part of conferring the requisite degree of hardness and stability to our frame—are, in fact, the earthy constituents of the skeleton. But there is another purpose for which water is employed, viz., for washing and which is hardly less important than that we have just considered. For this purpose hard water is certainly disadvantageous.

Soap contains fatty acids, which form insoluble compounds with the lime and magnesia in hard waters, and no lather will be produced till all the lime and magnesia dissolved in the water have been precipitated in this way. And this occasions a waste of soap.

Now, what is called the temporary hardness in water may be removed by boiling it. The expulsion of the dissolved carbonic acid gas by that means, leads to the removal of the calcic carbonate from solution in the water, and the hardness due to that cause is then removed. But the water may contain sulphate of lime in solution, which will not be removed by boiling the water. On the contrary, unless the water had been previously saturated with the salt, the evolution of steam in boiling would rather tend to concentrate its solution, and thus the permanent hardness due to this cause would remain. Moreover, there is a further objection to boiling water (except in small quantities) for the purpose of removing its hardness, since, besides the consumption of fuel which is necessarily incurred, the deposited calcic carbonate tends to form boiler incrustations, often of considerable thickness, upon the walls of the vessel employed for the

* A recent lecture before the Society of Arts, London.

purpose, and if they do not lead, as they have too often done, to dangerous accidents by their suddenly becoming detached, and producing explosive bursts of steam, by allowing the water to come in contact with the strongly heated metal wall of the vessel, yet must invariably cause great waste of fuel, owing to their inferiority as conductors of heat. Therefore, the process of Mr. Clark, which is conducted without any application of heat at all, was a great boon to mankind, especially as it has the additional advantage of clarifying a water as effectually as any filter.

The problem before us is essentially this. How may dissolved calcic (and magnesic) carbonate be best removed from solution in water? *i. e.*, how may these salts be converted into suspended and insoluble matter with the smallest possible expenditure of time and money? We have seen that the method of boiling the water, though effectual, is objectionable on the score of expense, liability to accidents, etc. Now, in Mr. Clark's process, which I have said is preferable, the suspended insoluble calcic carbonate produced has to be removed by subsidence. There are two methods by which suspended matter is removed from water in nature, subsidence and filtration, and these processes are also adopted by man for the same purpose. Now, it is claimed for the method of purification by filtration that organic matters are oxidized by the substances employed, *e. g.*, charcoal, which has the property of retaining oxygen gas in its pores. But the process of Mr. Clark also undoubtedly removes dissolved organic matters from waters, the lime which is added acting as a mordant, and producing their precipitation, Mr. Clark's process is as follows: By adding quicklime or hydrated (slaked) lime to a carbonated calcareous water, the carbonic acid gas, which is holding the carbonate of lime in solution, is first removed by combination with the added lime, and the carbonate of lime thus produced falls, together with that previously in solution, as a solid insoluble precipitate. The turbid water is left to clear by subsidence, and if afterwards drawn off freed from temporary hardness.

I have hitherto been speaking of what may be called unavoidable impurities in water—impurities, viz., which are introduced by natural processes which are beyond the control of man; but before concluding, I must allude, however briefly, to a very important accidental source of contamination of waters which is sometimes introduced by man himself, I mean the contamination of water with lead. And here we shall find that the influence of dissolved matters in any water is extremely important in modifying its solvent action upon this metal. Lead, from the ease with which it is worked, and the resistance which it offers to atmospheric action, changes of temperature, etc., has been found to be a very convenient metal wherewith to construct pipes for conveyance of water and cisterns for its storage. But lead is dissolved in appreciable quantities by some natural waters, and the long-continued ingestion of that metal, even in very minute quantities, produces serious symptoms of disease in the human subject, so much so that the metal has given its name to at least two specific affections, lead colic and lead palsy. It becomes, then, a matter of the utmost importance to be able to state, from a knowledge of the ingredients of any given water, whether or not it will be safe for persons to drink that water after it has been stored in leaden cisterns—whether or not that particular water is likely to exert any solvent action upon the metal. This we are able, in many cases, to do. For it has been found that pure water, free from both dissolved solids and gases, has no solvent action upon lead. But water containing dissolved oxygen becomes impregnated with lead, oxide of lead being, to a certain extent, soluble in water.

1. Practical deduction: Rain-water, stored in lead, must not be used for drinking purposes. Again, when waters containing carbonates, and especially sulphates, in solution are stored in leaden cisterns, the metal becomes coated with an insoluble protecting film of carbonate and sulphate of lead, further action being thereby prevented, and the water does not become saturnine.

2. Practical deduction: Carbonated and sulphated calcareous waters may usually be stored in lead with impurity. The film which forms on the surface of the metal should by no means be removed.

3. Waters containing nitrates and chlorides in abundance cannot safely be stored in leaden cisterns, since the nitrate and chloride of lead are soluble salts. The practical deduction from this is obvious.

In concluding, I hope I have convinced most of my hearers that, though we do not drink pure water, it would be very much worse for us if we did, and that, while we may sometimes be inclined to ask, "Why is such a substance here?" we generally find at last that it serves some important purpose which had escaped our ken—in fact, that we are finally led to wonder at the wisdom which works through intricate and complicated labyrinths to a perfect and simple end, and are forced to admire the ultimate tendency and result of even such seeming anomalies as the "impurities in water."

DISCUSSION.

The Chairman said, as his chemistry was of a very ancient date, he should not venture, in any remarks he might be bold enough to make, to discuss the chemical part of the subject. He had been exceedingly gratified by the lucid exposition of that part of the extensive subject which Mr. Johnson had selected, as well as by the well-devised experiments which had been performed, and which had brought out so fully the illustration of the principles laid before them. It was quite necessary to avoid, in a paper such as this, entering upon the extremely extensive and difficult part of the subject involved in the consideration of the organic impurities of water, as that could only satisfactorily be dealt with in a separate paper. A great part of his life had been divided between two residences, in which very opposite extremes in the condition of water existed, so that he had had an opportunity of observing, in a general way, the effects of these conditions.

At Aberdeen he used the water of the Dee, which approached almost to distilled water, with the exception of course of the gases, and in Glasgow the water of Loch Katrine, which was equally pure with the water of the Dee, and in both instances he was made aware of the circumstances which Mr. Johnson had so well explained with reference to the disadvantage that might arise from the purest water, more especially from the solution of the leaden pipes through which the water passed, or from the cistern in which it was kept. The introduction of slate cisterns must be considered a very great advantage, as they protected one against the risk, which might occur from keeping water for a long time in leaden cisterns. With respect to pipes, he was quite aware of the evil when they were new; and if the cistern was of slate, it was only necessary that the water should be run through the pipe a short time, in order to escape the danger which might arise from the water remaining a considerable time in the leaden pipes.

He had known an instance of lead colic being produced simply from inattention to this precaution. He had also had ample experience of the process for softening water, for it so happened that the water supplied to the house in which he lived near Edinburgh was the hardest with which Professor Clark had ever come in contact. Few were aware of the evils belonging to extreme hardness of water. The water to which he referred, when used for boiling meat, had the effect of making it quite red, vegetables shriveled up in a most wonderful way under its influence, kettles became encrusted, tea could not be made, and washing with it was quite out of the question. For the cure of this, by Dr. Clark's direction, he added a ninth part of lime water to the ordinary water, and during the night a subsidence, not only of the whole of the carbonate of lime, but of all the impurities took place, the water being then fit for domestic use. Those present must have been convinced by the author of the advantages which should belong to such impurities when occurring in a moderate degree, though they might not go to the length which the well-known old lady of St. Andrew's did, who, when great efforts had been made to introduce new water in the place of one which had not been favorably looked upon by the inhabitants before, said that she did not think much of the new water, as it had neither taste nor smell.

HARDNESS OF WATER.

By V. WARTHA.

IN order to ascertain the alkalinity of springs on the spot, with samples not exceeding 10 c. c., and with a single reagent, the author makes use of a tube of 30 to 40 cm. long, closed at the bottom, and with a mark showing the capacity of 10 c. c. From this mark upward the tube is graduated into 0·1 c. c. To determine the temporary hardness the tube is filled to the lowest mark with the water in question, and a little piece of filter-paper, which has been previously steeped in extract of logwood and dried, is thrown in, thus giving the water a violet color. Centinormal hydrochloric acid is then added from a dropping bottle, till the color of the liquid inclines to an orange. The tube is then closed with the thumb and well shaken. The greater part of the carbonic acid escapes, and the liquid becomes red again. Acid is again added, and the shaking repeated until the next drop of the acid turns the liquid to a pure lemon-yellow, a point which with a little practice is easily reached. The amount of acid used is read off on the tube itself. The author proposes to express the alkalinity of a water by the number of c. c. of centinormal acid needed to neutralize 10 c. c. He thinks that this method will be found useful both for sanitary and geological purposes.

CHLOROPHYL.*

AN account was given in *Nature*, vol. xxi., p. 85, of Prof. Pringsheim's first publication on this subject. He had then found that exposure to intense light for a few minutes causes the chlorophyl-corpuscles contained in the cells of plants to lose their green color: he also pointed out that this effect is produced not by heat but by light, and only in the presence of oxygen, and further, that the highly refrangible rays of the spectrum are those which are principally concerned in it. He also announced the discovery in the chlorophyl corpuscles of a substance termed hypochlorin.

The paper now under consideration gives a full account of all the observations and experiments which he has made up to the present time, and he considers that they tend to confirm the conclusions at which he had previously arrived. It will be well, before entering upon a discussion of the very difficult questions which are raised, briefly to enumerate the principal new facts which he now brings forward.

In the first place, he is able to throw some light upon the intimate structure of chlorophyl corpuscles by means of a new method for investigating them. This method consists in treating them with a dilute acid (*e. g.* 1 vol. of glacial acetic acid to 2 of water, or 1 vol. of picric acid to 3-6 of water, or 1 vol. of sulphuric acid to 20-40 of water, or 1 vol. of strong hydrochloric acid to 4 of water), or warming them in water, or exposing them to the action of steam. The effect of this treatment is to cause the escape of the chlorophyl from the corpuscle, together with certain fluid or semi-fluid substances which accompany it, in the form of viscid drops, leaving the ground-substance of the corpuscle as a colorless, apparently protoplasmic, hollow sphere, with a much perforated wall.

These viscid green drops, when produced by the action of warm water or of steam, appear to consist of an oil which holds the chlorophyl and other substances in solution. When they are produced by means of a dilute acid, they appear to contain a substance which is not present when they are extracted by warm water or by steam. Certain dark brown masses make their appearance, which are of a tolerably firm consistence and of varying form. These gradually become harder, and assume a crystalloidal appearance, probably, as Prof. Pringsheim suggests, in consequence of a conversion into resin of the oily matter which is present; but it is by no means the whole of the substance which thus solidifies, but only a certain constituent of it. The color of the mass is doubtless due to the presence of altered chlorophyl, and this may affect even the crystalloids, but they may be obtained colorless. It is to the substance which assumes the crystalloidal form, or rather to some substance pre-existent in the chlorophyl-corpuscle from which these crystalloids are derived by the action of the acid, that Prof. Pringsheim gives the name of hypochlorin.

He meets the doubts that may arise as to the chemical individuality of this substance, as also the suggestion that it may be a product of the alteration of the chlorophyl, by pointing out that it cannot usually be obtained at any one time from all the corpuscles of a given cell. It is, therefore, a substance which, as it is present in some and not in others, cannot be derived from chlorophyl which is present in them all, and which probably bears some definite relation to the metabolic processes going on in the corpuscles.

Since no hypochlorin can be obtained from cells which have been warmed in water or acted upon by steam, it appears that this substance is decomposed by heat.

After giving a detailed description of the arrangement of the apparatus used in his observations, Prof. Pringsheim goes on to give an account of the effects produced by exposure to intense light in the different parts of which the cell consists. He again insists that none of the following phenomena can be the results of excessive heating of the object, for he found that cells not containing chlorophyl (*e. g.* colorless zoospores) could bear the exposure for half an hour without injury, and further, that the phenomena were produced more readily by blue or green light than by red light, which has a much greater heating effect. The principal phenomena observed are as follows:

1. The coloring-matter.

The chlorophyl-corpuscles lose their color in a few minutes, but this does not take place when oxygen is not present, nor in red light. There is no trace of chlorophyl left in the corpuscles. Prof. Pringsheim is therefore of opinion that its decolorization is a phenomenon of oxidation, and that the products are gases. Further, this disappearance of the chlorophyl is not prevented by the absence of carbonic acid gas. The corpuscles which have lost their green color do not regain it, although the cell in which they are contained still continues to live; on this account Prof. Pringsheim regards the decomposition of chlorophyl as a pathological and not as a normal process.

Coloring matters, other than chlorophyl, which occur in the cells of plants, are likewise decomposed, but not all of them. Thus, the blue pigment of the Phycochromaceæ, the brown of Fucus, the red of the Florideæ, the orange of the corolla of Calendula, the blue in the cells of the staminal hairs of *Tradescantia virginica*, disappear, but the blue pigment in various flowers is not decomposed by exposure to intense light.

2. The ground-substance of the chlorophyl-corpuscles and their contents.

If a cell of Nitella or of Spirogyra be killed by the action of heat, for instance, the chlorophyl-corpuscles of the one and the spiral band of the other will absorb water and swell up. If the cell has been killed by prolonged exposure to light, no such absorption of water will take place.

Prof. Pringsheim mentions starch, oil, and tannin as commonly occurring in the chlorophyl corpuscles;* these substances, which contain a considerable proportion of oxygen in their molecule, are not affected by the action of light.

3. Hypochlorin.

No trace of this substance can be detected in cells which have been exposed.

4. The protoplasm of the cell.

The turgidity of exposed cells is lost; the protoplasm readily allows coloring matters to pass through it, and treatment with plasmolytic reagents produces no contraction. In a long cell, part of which has been exposed to the action of light, it is only the portion of the protoplasm which has been exposed that exhibits these alterations in its properties. Moreover, these changes are apparently accompanied by a perceptible loss of substance.

A brief exposure causes an arrest of the rotatory movements of the protoplasm in cells which exhibit it. If the exposure has not been prolonged, these movements will recommence after a time. If a portion only of such a cell be exposed for not too long a time, the movements will be arrested in the exposed portion, whereas it continues in the rest of the cell.

5. The cell-wall.

The only effect which the exposure produced on cell-walls appears to have been that the cells of the more delicate filaments of species of Spirogyra and Mesocarpus become isolated.

The following are the general conclusions which Prof. Pringsheim draws from the facts which have been stated above. He concludes that the injurious effects produced by the exposure of a cell to intense light in an atmosphere containing oxygen, are due to an increased oxidation of certain substances which are essential to its life. The rays which are active in this process are not those which reach the interior of the cell after having passed through the chlorophyl-corpuscles, but those which reach it directly. He finds, it is true, the cells which do not contain chlorophyl are, on the whole, less sensitive to the action of light than those which do contain it, but there are no grounds for believing that this greater sensitiveness is due to the absorption of any light-rays by the chlorophyl. On the contrary, the presence of chlorophyl in a cell seems rather to diminish than to increase the oxidizing action of light. Facts are adduced to show that chlorophyl exercises a protective influence in this respect, and it is further pointed out that the death of the cell, when exposed to intense light, takes place *before* the complete decolorization of the chlorophyl-corpuscles has been effected. The greater sensitiveness to the action of light of a cell containing chlorophyl is ascribed to the presence in it of the readily oxidizable products of its assimilatory activity, and of these hypochlorin is the most important.

Prof. Pringsheim's theory of the function of chlorophyl is, then, (1) that the respiration of a cell is increased by exposure to light; (2) that, in consequence of the absorption which takes place when light passes through chlorophyl, the presence of chlorophyl in a cell tends to counteract the influence of light, so that, when the light is not intense, the respiration of the cell is so far diminished that processes of reduction can take place within it, but when the light is very intense the chlorophyl itself undergoes decomposition, and the death of the cell is brought about by the excessive oxidation of certain of its essential constituents.

After having stated his own views, Prof. Pringsheim proceeds to criticise the current hypotheses concerning the function of chlorophyl. The first of these is the one according to which chlorophyl is itself converted into carbohydrate in the assimilatory process. It is not easy to understand, from a chemical point of view, how such a conversion can be effected in the plant, and it becomes quite impossible when it is shown, as Prof. Pringsheim has done, that chlorophyl does not undergo any perceptible change when it is exposed to light in an atmosphere containing carbonic acid but no oxygen.

The second relates to the absorption-spectrum of chlorophyl. The question naturally arises as to whether or not the rays which chlorophyl absorbs are those which effect the reduction of carbonic acid and water in the chlorophyl-corpuscle. That it must be answered in the negative is clear when it is borne in mind that the maximum, of the decomposition of carbonic acid does not coincide with the maximum of absorption in the chlorophyl-spectrum. From what source, then, is the energy derived which is necessary for this reduction? It is derived, according to Prof. Pringsheim, from light-rays absorbed, not by the chlorophyl, but by the other cell-contents. He is of opinion that the chlorophyl takes no direct part in this process.

* "Untersuchungen über Lichtwirkung und Chlorophyllfunction in der Pflanze," by Prof. N. Pringsheim (*Jahrbücher für Wiss. Bot.*, Bd. XII., Heft 3: Leipzig, 1881.

* He quotes the observations of Briosi to prove that oil and not starch, is the substance which is formed in the chlorophyl-corpuscles of the Musaceæ, without being aware, apparently, that Briosi's results have been shown to be incorrect by Holle and Godlewski ("Flora," 1877).

The next question which is dealt with is the existence of an optimum intensity of light for the decomposition of carbonic acid. Prof. Pringsheim does not consider that this is the intensity which effects the greatest evolution of oxygen, for, from his point of view, the amount of oxygen given off at any time is the resultant of the action of two distinct processes, respiration and assimilation, both of which are affected by the intensity of the light. He concludes that, so far as an actual gain of carbon is concerned, there is no general optimum intensity. He applies this mode of reasoning also to the question of the relative activity of the different rays of the spectrum in the process of assimilation. The green and yellow rays have been found to be more active than the blue, because, as he points out, they are not absorbed to the same extent by the chlorophyl, and not because they are endowed with any special reducing power. Finally, he proceeds to the discussion of the fact that the volume of an atmosphere in which green plants are exposed to light remains constant. This fact has led to the conclusion that, since the volume of carbonic acid decomposed and of oxygen exhaled is the same, the substance formed in the process is a carbohydrate. Prof. Pringsheim's inference from this fact is very different. He argues that since oxidation and reduction are going on simultaneously, the substance formed contains a smaller quantity of oxygen than a carbohydrate—in fact a quantity which is smaller by just that amount of oxygen which has been used up in respiration.

Stated in the briefest possible manner, Prof. Pringsheim's principal results are as follows:

1. That the presence of chlorophyl favors the assimilatory activity of the chlorophyl corpuscle in consequence of the absorption, by the chlorophyl, of light, which would promote the respiratory activity.

2. That hypochlorin is the substance which is the first visible product of this assimilatory activity, and that the other substances (starch, glucose, oil, tannin) which are found in chlorophyl-corpuscles are derived from hypochlorin by oxidation. This conclusion is based upon the general occurrence of hypochlorin in chlorophyl-corpuscles, upon the fact that the amount of hypochlorin in a corpuscle varies inversely as the quantity of starch which is present, and upon the observation that hypochlorin cannot be detected in seedlings until they have been exposed to light of such an intensity as to enable them to assimilate.

It is of interest to note that hypochlorin makes its appearance at the later stages of germination in seedlings of various species of Pinus which have grown in the dark, inasmuch as it has long been known that these plants become green in darkness.

This paper cannot be regarded as other than a most important contribution to our knowledge of the physiology of plants, and it will be readily admitted that Prof. Pringsheim's theory of the function of chlorophyl is at least as satisfactory as any which are now current. But although the number of facts upon which the theory is based is large, yet the evidence in favor of it can hardly be considered to be complete at present; there are certain points which require further elucidation. For instance, Prof. Pringsheim regards the chlorophyl of a corpuscle as undergoing no change under ordinary circumstances, but it is difficult to reconcile this view with the fact that an alcoholic solution of chlorophyl loses its color under the same circumstances. Then again, as to the source of the reducing energy in the process of assimilation, if the rays absorbed by the chlorophyl are not directly concerned in it, it is most desirable that more information should be obtained as to the nature of the rays which are active, and as to the particular cell-contents which absorb them. Further, the correctness of the principle that an increase in the intensity of light to which a cell is exposed produces an increase of its respiratory activity, needs more direct and general experimental confirmation than is given here. In his views as to the respiratory function, he appears to insist too strongly that the chlorophyl-corpuscles are to be regarded not only as assimilatory, but also as respiratory organs.

It is not easy to see that any of the observations which he gives in this paper directly suggest such a view; on the contrary, they tend rather to show that exposure to intense light increases oxidation in the *whole* of the protoplasmic cell-contents. Prof. Pringsheim evidently desires to bring out that hypochlorin is *the* substance which undergoes oxidation in the cell, and since it is present exclusively or nearly exclusively in the chlorophyl-corpuscles, he considers that these bodies are the especial seats of the respiratory process. His observations, however, do not warrant this conclusion; what they prove is that the hypochlorin in the chlorophyl-corpuscles is oxidized when they are exposed to intense light in an atmosphere containing oxygen, and that certain changes (including a loss of substance) take place in the rest of the protoplasm, in consequence, doubtless, of the excessive oxidation of some substance or substances which it contains. His view may be fairly met with the *a priori* objection that it is highly improbable that the same organ should be the seat of two such opposite functions as respiration and assimilation. The true physiological significance of the chlorophyl-corpuscles becomes apparent when it is borne in mind that assimilation does not take place in cells which do not possess them, whereas respiration proceeds actively, perhaps most actively, in such cells.

And, finally, as to hypochlorin, it is to be hoped that a method will be devised for the extraction of this substance in such quantities as to allow its properties to be studied and its chemical composition to be ascertained. The curious fact that hypochlorin cannot be detected in plants which are not distinctly green (Diatomaceæ, Fucaceæ, etc.), is worthy of further investigation.

These desiderata may perhaps be supplied in the future publications on this subject which Prof. Pringsheim promises.—*Sydney H. Vines, in Nature.*

LIQUEFACTION OF GASEOUS MIXTURES.

By MM. CAILLETET and P. HAUTEFEUILLE.

IN general the assimilation of the solution of a gas to its liquefaction is very imperfect, even in the case where the solution is completely destroyed by the action of a vacuum, for the evaporation-heat of a liquefied gas is always weaker than its solution-heat. We may, therefore, always suppose a chemical action when a gas dissolves in a liquid, but if this chemical action, as measured by the difference of the two heats just mentioned, is equal to the heat of contraction of the mixture of the two bodies taken in the liquid state, the assimilation becomes perfectly legitimate. The mixture of carbonic acid and cyanogen may be considered as the type of the liquids which the authors have been studying. This mixture preserves its characters at temperatures much higher than that which corresponds to the critical point of its more readily liquefiable element.

THE ALLOYS OF MANGANESE.

WHEN the metal manganese was first discovered in 1774 by Fredrik Gahn, the celebrated Swedish mineralogist and chemist, in reducing it from the natural oxide in a small crucible, nobody could have foreseen that the identical body, only combined with a few per cent. of carbon and iron, would, a hundred years hence, be produced in the largest blast furnaces, and at not very much greater cost than common crude iron. When this grayish-white and very brittle metal was first made known, its properties seemed to render it unfit for any practical use, as it required a very great heat for its reduction from the ore, and when exposed to damp air, it would rapidly decay or crumble to pieces. Although the metal was known to exist to some extent in the so-called "spiegeleisen," and although it was many years ago thought to be essential in the manufacture of the very best German shear steel, nobody took the trouble to produce metallic manganese on purpose. Oxidized manganese was, however, at an early date, a frequent admixture in the manufacture of ordinary cast steel or crucible steel, and by the Sheffield steelmakers particular cleansing or strengthening properties were attributed to it, in more good belief than reality.

It was only after M. A. Valenciennes, in 1870, had succeeded in producing, in a magnesia crucible with a gas-furnace, pure manganese metal in the molten state from pure hyperoxide of manganese, and had exhibited this to the French Academy, that fresh attention was directed upon this peculiar and, as is now generally acknowledged, highly useful metal. Thus, Dr. John Percy, in 1873, proposed to employ manganese instead of nickel in the manufacture of German silver, an alloy which contains copper and zinc besides. At that time also H. Tamm was able to produce an alloy of manganese and iron, with 96 per cent. of the former; while at Jauerburg in Carniola, ferro-manganese, an alloy of iron with carbon and up to 30 per cent. of manganese, had been successfully produced in the charcoal blast furnace and on a large scale. Since then the production of either pure metal or of its alloys with iron has been attempted by many English and foreign metallurgists, and by the employment of very different methods. The palm must, however, be given to those who have succeeded in producing ferro-manganese, containing from 80 to 90 per cent. of the metal, by using the ordinary blast furnace as a reductor and coke as fuel. Such specimens were largely exhibited at the late Düsseldorf Provincial Exhibition by the Phœnix Iron Company, of Ruhrort, and the Gutehoffnungs-Hütte of Oberhausen, while alloys of manganese with copper, zinc, tin, and lead were shown by the Brothers Heusler, of Dillenburg, in Nassau. They are remarkable for their extraordinary strength, toughness, and hardness, which may be produced at will by varying the quantities of the component metals.

When we look at the progress which the production of ferro-manganese—or, as we now may well call it, "crude manganese"—has made during the last few years, we find it to be quite astonishing. The reduction of manganese in combination with iron and carbon was attempted as long ago as 1865 by several metallurgists, such as Prieger, Bessemer, and others who employed crucibles, and by W. Henderson, who used the Siemens furnace for this purpose; and while the latter succeeded in getting a compound with about 30 per cent., the crucible process was able to produce an alloy with 60 per cent. of manganese, spiegeleisen at that time hardly ever containing above 12 per cent. of the metal. This was the state of the manufacture of manganese compounds when at the Vienna International Exhibition in 1873, the "Krainer Eisen- und Stahlwerks-Gesellschaft," of Laibach, in Carniola, produced specimens of spiegeleisen with nearly 20 per cent., and others of ferro manganese of a far higher percentage, which were then considered as something quite wonderful among metallurgical products. For, as was stated, they were products of the blast furnace, and very many tons of these compounds could every day be tapped from the blast furnaces of Jauerburg and Sava.

Though these statements met at first with some incredulity, it was nevertheless confirmed that the technical managers of the company, Chevalier von Banz and Mr. C. Luckmann, had indeed succeeded in employing the ordinary blast furnace with charcoal as fuel, for the production of the above-named compounds from a mixture of calcined carbonates and hydrates of iron, with manganese ore from Vigunsza. The samples showed the characteristics of spiegeleisen up to a content of 20 per cent. of manganese; above this, they lost all crystalline appearance, and became non-magnetic, with an almost homogeneous or fine-grained fracture. Some of these samples, taken at the Exhibition, gave by analysis, in 100 parts:

Carbon.....	5·33	5·31	5·28	5·27
Manganese.....	22·46	23·48	28·70	35·04

This great success stimulated the managers of the Reschitza Iron Works, in Hungary, to imitate the process, and after a good deal of trouble they were able to produce, with a slag, containing principally lime, manganese, iron, and alumina, and only slightly above 20 per cent. of silica, a compound with over 35 per cent. of metallic manganese. At the same time, in 1874, M. Jordan, at the St. Louis Iron Works, near Marseilles, also succeeded in getting from the blast furnace ferro-manganese with 20 to 25 per cent. At Terrenoire the Siemens furnace had been tried, since about 1868, in such a manner that bricks were made from an intimate mixture of calcareous oxide of manganese with pounded Mokta iron ore, fine coal, and pitch, which bricks were then burned and strongly heated in the Siemens furnace with an addition of spiegeleisen, when alloys with 60 per cent. could be obtained. The blast furnace process at Terrenoire, has, however, only been in use since 1877; and though over three tons of coke are required for one ton of ferro-manganese, an alloy containing from 72 to 74 and even 80 per cent. of manganese can be now made there, when a very basic and refractory green manganese slag is aimed at.

At the Düsseldorf Exhibition of 1880, the Phœnix Company of Ruhrort exhibited specimens of ferro-manganese from the blast furnace, made with coke and an extremely basic slag, in which silica is mostly replaced by alumina. They contained from 22 up to 77 and 80 per cent. of manganese, while the Gutehoffnungs-Hütte of Oberhausen was able to show samples containing 75 per cent of manganese with about 5 per cent of carbon, and besides iron only traces of sulphur and phosphorus.

Such is the present state of manufacture of "crude manganese," which will find a still larger use in the metallurgy of steel the more the basic Bessemer process spreads, as its addition is necessary to restore to the overblown iron the required amount of carbon and to free it by the aid of manganese from its last traces of sulphur, which are left even after phosphorus is entirely eliminated. The success of the blast-furnace process depends, next to a high temperature and to an extremely basic slag with very little silica, to an intimate mixture of the oxides of iron and manganese as it is found in the natural carbonate ore or the knebelite ore of Sweden, which is a silicate of equal proportions of protoxide of iron and manganese. Whenever the mixture is artificial, the most intimate contact must be looked for, because the reduction of manganese is much more owing to the action of metallic iron than to that of carbon, the former playing an intermediate *rôle* because it is easily reduced by carbon, and then helps to render the manganese metallic.

Besides the alloys with iron and carbon, those with copper, tin, and zinc are, as before mentioned destined to become of great importance for many industrial, and especially mechanical and engineering purposes. It is as long ago as 1848 that the late Chevalier von Gersdorff, of Vienna, succeeded in producing alloys of manganese and copper, and that soon afterwards Professor A. von Schrötter, Master of the Mint at Vienna, made similar compounds by reducing a mixture of oxides of manganese and copper with charcoal in a crucible at a very high temperature, which compounds contained from 16 to 20 per cent. of manganese. Professor von Schrötter was also the first to substitute manganese for nickel in German silver and similar alloys, as was later on proposed by Dr. Percy, in London (as already noted above), and by Mr. Allen, in America. The low price of nickel at that time seems, however, to have prevented the more general application of manganese for this purpose. Since Von Gersdorff's endeavors to produce an alloy of manganese with copper, but few experimenters seem to have followed this path. Thus we find only in 1876, in Germany, Brothers F. and C. Heusler, of Isabelle-Hütte, at Dillenburg in Nassau, E. Biermann, of Hanover, and S. Elster, of Berlin, as manufacturers of manganese bronze; while at the Paris Exhibition of 1878 similar alloys were shown by the White Brass Company of London, and by a copper works in Southern France, which exhibited an alloy of 7·5 copper with 25 manganese, under the name of "cupro-manganese."

While most experimenters had succeeded in combining both metals *in statu nascendi*, that is, by simultaneous reduction from their respective oxides, Heusler Brothers, of Dillenburg, recognized a greater advantage in reducing metallic manganese from pure pyrolusite for itself, and afterward alloying it in any required proportion with other metals. The reduction takes place in large plumbago crucibles with an admixture of carbon and of very basic materials by which, after six hours' smelting in a powerful coke fire, "crude manganese" is obtained, this containing 90 to 92 per cent. manganese, 6 to 6·5 carbon, 0·5 to 1·5 iron, and 0·5 to 1·2 silicon. The crude metal can be refined to contain 94 to 95 per cent. of manganese when it is remelted with a suitable flux, and this metal contains only combined carbon, while in its crude state graphitic carbon also is almost always present. The refined metal is white with crystalline fracture, and it oxidizes slowly when exposed to damp air; it is, therefore, soon combined with copper, thus forming "manganese copper," with 70 parts of copper and 30 parts manganese.

The alloy is either cast in ingots or shot and becomes a commercial article in this state; its fracture is of steel-gray color and very close, and it is not difficult to combine it in any proportion with other metals or alloys of metals, such as brass, bronze, gun-metal, bell-metal, yellow-metal, and others. The same combination has been found a very powerful "physic" in refining copper, because the manganese will take up all oxygen which is absorbed by the bath of refined copper in the refining furnace before it is made tough, either by an addition of lead or by an insertion of a pole of green wood.

Trials made at the Mansfield Copper Works have proved that an addition of 0·45 per cent. of manganese-copper is sufficient to toughen copper, which only retains from 0·005 to 0·022 per cent., while the greater portion, after having taken away the absorbed oxygen, is carried off in the refinery slag. Manganese-copper has also a beneficial influence upon the toughness and density of thin copper castings, such as thin sheets, tubes, kettles, caldrons, and other kitchen utensils, which formerly were beaten or pressed into shape; copper cast with an addition of the alloy shows itself extremely tenacious, and tubes of 3 centimeters (1¼ in.) diameter and only 1·75 millimeters (0·07 in.) thickness will stand a pressure of over 1,100 lb. per square inch, when water begins to be pressed through the pores of the metal. It appears that "cast copper," which can be brought in any required shape without the necessity of soldering, beating, hammering, pressing, or drawing, will in future play a considerable part in the arts and manufactures.

"Manganese bronze," that is, an alloy with copper and 1 to 10 per cent. of manganese, which has been introduced by Mr. P. M. Parsons, is already at this time highly appreciated for its excellent qualities, that is, its strength, ductility, toughness, and hardness. The greatest absolute cohesion of manganese bronze was found with a content of 1 to 4 per cent. of manganese, while with a greater proportion it becomes less, and with above 12 per cent. the alloy is too brittle to stand any great pressure. The subjoined table gives the results of trials made with some alloys of varying composition upon the testing machine at Friedrich Wilhelmshütte to ascertain their absolute breaking strength in kilogrammes for one square millimeter, and in tons per square inch, and the elongation in per cent. before rupture takes place:

Copper (parts).....	96	95	94	90
Manganese (parts)	4	5	6	10
Breaking strength (kilogrammes (per square millimeter).....	19·0	20·62	20·8	16·56
Breaking strength (tons per square inch).....	12·3	13·24	13·46	11·02
Elongation (per cent.)....	14·6	10	14·6	5

This table shows the results with raw ingots; the strength is, however, greatly increased by rolling or hammering, as is also the case with copper.

"Manganese German silver" was made from 70 copper, 15 manganese, and 15 zinc; but as this alloy proved rather brittle in the rollers the proportions were altered to 80 copper, 15 manganese, and 5 zinc, when a beautiful white and ductile metal was obtained, which would take a high polish. It appears, however, that the ordinary nickel alloy will only be gradually superseded by manganese compound.

Of far greater importance are the "manganese tin and zinc bronzes," which were perhaps among the first upon which experiments were made on a large scale. They were obtained by adding to an alloy of copper, tin, and zinc, a certain quantity of "manganese copper," viz., the combination of 70 copper with 30 manganese as above described, by which an increase of at least 9 per cent. of strength is obtained over the ordinary alloy. This seems to be greatly due, as in the case of the refined tough copper, to a chemical

action of the manganese; for all ordinary bronzes contain more or less oxides of copper and tin, which are reduced to metal by the action of the manganese. An addition of manganese seems, however, to have also physically a strengthening effect, and an addition of from 3 to 6 per cent. of manganese copper has been experimentally found to suit the purpose best.

Manganese and tin combine as readily as manganese and copper: tin, however, shows, as in ordinary bronzes, a tendency to separate itself in the middle of thick castings from the other alloys, because it remains longest in a fluid condition, and under the process of solidification it seems to get squeezed out of those parts of a casting which retain the heat longest.

An important series of experiments made at Isabelle-Hütte have shown that the strongest "manganese tin bronze" is obtained by alloying 85 copper with 6 tin, 5 zinc, and 5 manganese copper, so that the cooled product retains something above 1 per cent. of manganese. The best mode of procedure is first to melt the copper in a crucible, then to add successively tin and zinc, but manganese copper only at the last moment, when the metals are well stirred up with a rod made from gas retort graphite; a reaction upon the oxides of the metallic bath is clearly noticed, as it begins to boil and to emit sparks after the addition of manganese, of which a portion is carried into the slag. Subjoined is a table of trials made with a series of rough ingots of the metal:

No.	Cast in	Copper.	Tin.	Zinc.	Manganese Copper.	Breaking Strength, Tons per Square Inch.	Limit of Elasticity, Tons per Square Inch.	Elongation, Per Cent.
1	sand	85	6	5	..	10·3	7·24	
2	"	85	6	5	4	10·34	8·4	2
3	iron	87	8·7	4·3	4	12·51		
4	"	85	6·9	5	6	12·13	..	6
5	"	85	6	5	6	12·7	..	7
6	"	85	6	5	10	11·05	..	5
7	sand	87	5·20	4·33	3·47	12·63	..	8·7
8	"	87	5·20	4·33	3·47	12·7	..	8·9
9	"	85	6	5	3	14·09	10·8	
10	"	74	10	5 (7·66 lead)	3 3	12·06	8·9	
11	"	78·7	8	(8 lead)	3·3	13·33	8·9	
12	"	82	9·8	4·9	3 3	12·7	9·5	
13	"	86·2	16·5	..	3·3	15·87	9·2	

The trials for strength, elasticity, and elongation noted above were made with testing machines at Friedrich Wilhelmshütte and at the Nippes Central Engine Works of the Rhenish Railway, upon ingots cast at Isabelle Hütte, near Dillenburg. The absolute strength of these alloys is considerably enhanced when the ingots are subjected to judicious forging or rolling. The White Brass Company of London, indeed, reaches in this manner with manganese-bronze, the strength of good steel plates, giving a breaking strain of from 27 to 30 tons per square inch. For the above data relating to manganese-copper, manganese-bronze, and manganese-tin-bronze, we are indebted to a communication made by Oberbergrath C. Heusler, in March last, to the Berlin Society for the Advancement of Industry, and we may add that these alloys are now largely employed by many private and state engine works for bearings, valves, stuffing-boxes, nuts and bolts, and other purposes where a corroding action of water, acids, or grease is to be anticipated and has to be carefully avoided. The compounds considerably surpass in strength and durability gun-metal, brass, and other compounds which have until now been generally in use for engineering and other purposes.—*Engineering.*

SOCIETY OF CHEMICAL INDUSTRY.

THE first general meeting of this newly-formed society was lately held in the rooms of the Institution of Civil Engineers, Great George street, Westminster, London, the chair being taken by Professor Roscoe, the President. The aim of the society is to bring more closely together the scientific chemist and the practical man, or, as it is worded in the laws, "to promote the acquisition and practice of that species of knowledge which constitutes the profession of a chemical engineer."

The General Secretary (Mr. George E. Davis), read the report of the council. It stated that, although three months had not yet elapsed since the inaugural meeting, there were nearly three hundred names on the register. The society was intended to include all in any way connected with chemical science, and among its members were technical, analytical, and manufacturing chemists, professors and demonstrators, alkali manufacturers, chemical engineers, brewers, sugar refiners, distillers, etc., etc. The society was already well known not only in the United Kingdom, but on the Continent, in America, and even in India. Four distinguished German chemists had already joined the society. It was suggested that in order to meet the difficulty of country members attending the meetings in the London district, branches should be formed, at which papers should be read and discussed, each member having a right to attend any district meeting if opportunity offered. It was proposed that the annual general meetings should be held in various towns throughout the country, and that, as soon as funds permitted, a journal should be published.

The President delivered his inaugural address, of which the following is an abstract:

The President said the main object of this society was to bring together persons interested in or possessing a knowledge concerning the utilization of chemical action on a large scale, and who had charge of or were connected with those large branches of industry dependent upon chemical principles. The interchange of ideas by the members would contribute to the advancement of the important branches of national industry which were dependent on chemical principles; and this it was hoped to do not only by bringing forward new processes, or discussing the advantages or disadvantages of old ones, but also by acting as a bond of union between individuals engaged in cognate pursuits, giving them a personal interest in one another, and thus encouraging that good fellowship which was not an unimportant factor in the smooth working of the social machinery. The receptive power of the society was very large, and its promoters relied upon interesting not one class of chemical manufacturers merely, but every class, and they believe that the advantages of meeting the representatives of allied and even dissimilar branches of industry would be great and distinct, since the scientific principles upon which various chemical manufactures were based were common to all. Much had been heard lately about foreign competition, and even the decay of English manufactures; but that those who led the way and had the advantage of the start in the race should feel this competition was not at all surprising. He for one did not believe that English manufacturing skill was on the wane, or that the inventive genius of the people was dying out. Only let an Englishman know what was really wanted and he would take care that it was obtained, whether that want were an increased technical skill, or a wider diffusion of the knowledges of technical principles. To assist in this direction, and to enable them more satisfactorily to meet the inevitable increase of foreign competition, was one of the objects for which the society had been formed. The President then referred to a few of the special fields of usefulness which were opened to the society, and gave long and interesting accounts of the past and present position of the alkali, soap, and coal tar industries. In conclusion, the President said he trusted he had shown good cause not only for the foundation of the society, but for its success, and he looked forward with confidence to the time when it would play no inconsiderable part in fostering, improving, and upholding the chemical industries of the United Kingdom.

Professor Charles Graham read a long and elaborate paper on the "Brewing of Lager Beer." The Professor first described the English system of brewing, and then referred in detail to the various methods of mashing and fermenting adopted in Continental breweries, especially those in vogue at Vienna, Pilsen, Cuembach, Bamberg, Nuremberg, and other places. He then gave a large number of analytical results, showing that German beers are less alcoholic but richer in dextrine and albuminoids than English beers, and he pointed out that the ratio of maltose to dextrine is much higher in English than in German beers; these analyses also proved that the majority of the Continental beers which now reach this country are brewed specially for the English taste, as they are far more alcoholic than the beers sold in the country of their origin. Special attention was drawn to the German system of preserving beer by ice, which was compared with the English system of preserving by large additions of hops. It was calculated that each barrel of lager beer requires 3 cwt. of ice for its production and preservation, and that ice may be manufactured artificially by Linde's ice machine for 6s. a ton, so that the cost for ice is less than 1s. per barrel, while the diminished quantity of hops used, calculating them at the average price of 1s. per lb., would be 6s. to 7s. per barrel. The Professor then referred to the large consumption of lager beer by Germans, and spoke in favor of the introduction and manufacture of this beverage in this country.

The next paper was on "Mechanical Furnaces," by Mr. James Mactear. Dr. Siemens made a communication on the "Use of Coal Gas as a Heating Agent." He commenced by observing that no subject could be more suitable for the consideration of this new society than that of combustion, or, more properly speaking, that of the production of chemical energy and its application. The fuel at disposal was, generally speaking, coal, and it was generally used in its raw condition. He then gave the number of heat units in a pound of carbon of coke, and of average coal; but the number of heat units immediately rose to a much larger figure directly you got to gaseous fuel. Not only was much more heat produced with the same weight of fuel, but it required a less quantity of oxygen and a smaller draught. Among the other advantages of gaseous fuel were that it was much easier to produce combustion; a greater portion of solid fuel flew off, and the supply of oxygen could hardly keep pace with it, the result being the production of smoke. Again, with gaseous fuel the supply was constant, and the amount of air requisite could be regulated with the greatest nicety; it was also clean and saved labor. Lastly, results might be obtained which were not possible by the use of solid fuel. Gas could be heated to any degree almost within ordinary furnace temperatures before it entered into combustion, and air could be heated to a very high temperature, as he had shown with the furnaces he had been constructing for the last twenty years. In this way a combined cumulative action was possible, which enabled the highest possible temperature of combustion to be obtained, that point being limited by dissociation, as Bunsen and St. Clair Deville had shown. That point was very nearly attained in the gas furnace for the fusion of steel on what was called an open hearth. A diagram was exhibited showing the construction of such a furnace, which was explained in detail. Dr. Siemens then went on to speak of the various ways of dealing with solid fuel so as to produce gas from it, one being in a closed retort, as in the gas manufactories, and the other in such a regenerative furnace as he had described. He then went on to advocate the separation of the gas evolved from retorts into two portions, using only that given off in the middle of the process for illumination purposes, and carrying the other portion off in separate masses for heating purposes.

He dealt with several points of detail which had been raised, and informed Mr. Crowder that in Germany the gas furnace was in use in several places for steam boilers; the only obstacle to its more extended use was the first cost of erection.

CHEMICAL ACTION IN A MAGNETIC FIELD.

By IRA REMSEN.

I.—ON THE DEPOSITION OF COPPER ON IRON IN A MAGNETIC FIELD.

THE question whether a metal in the magnetized condition differs in its chemical conduct from the same metal unmagnetized seems to be a fair one to ask, but, on first thought, the chances appear to be very much against obtaining a satisfactory answer. A difference in the *intensity* of the action of the metal in the two conditions would naturally be looked for first; but how can such a difference be detected in ordinary cases? Take the action of hydrochloric acid on iron for example. If a piece of iron be magnetized and treated with the acid, and the amount dissolved in a given time compared with the amount of a similar piece of unmagnetized iron dissolved under exactly the same circumstances, perhaps a difference might be detected. But the conditions are very complex, and it would be difficult to draw conclusions from experiments of this kind, particularly as the differences with which we would have to deal would probably be very minute. It is, further, possible that the total chemical action which takes place between hydrochloric acid and a piece of magnetized iron, on the one hand, and that which takes place between the same acid and a piece of unmagnetized iron on the other, may be identical, while, at the same time, the action may be distributed differently in the two cases—in the one case taking place uniformly and in the other irregularly, being more intense in some places and less so in others. If this latter view be correct, and *a priori* it seems probable, then it should be possible to detect evidence of the influence of magnetism on chemical action. Taking again the case of iron and hydrochloric acid, if the action is irregular, then after it has continued for some time, the iron itself should present the evidence of this fact in an irregularity of surface. Figures of some kind should be etched on the iron, and these would indicate the distribution of the action, as they would, of course, be deepest where the action is strongest, and in general, the depth of the marks would be approximately proportional to the intensity of the chemical action.

Reasoning somewhat in the above manner, I was led a short time ago to undertake some experiments, the results of which are recorded in this paper. I have succeeded in showing, by means of a very simple experiment, which any one may repeat in a short time, that magnetism does, in some way as yet not understood, influence certain kinds of chemical action very markedly. Up to the present the experiments have been confined mainly to one particular case, that of the deposition of copper on magnetized iron. The results already reached in this case are so surprising and interesting that it appears to be desirable to put them on record at once, without waiting to take up other cases which will readily suggest themselves.

Experiments were first made on the action of dilute hydrochloric acid on thin iron sheets placed in thin glass vessels over the poles of magnets, but no satisfactory results were obtained. The iron used was as good thin sheet iron as I could get, but was very irregular in structure, and, if the magnetic condition of the iron had any influence on the action of the acid, the effects of this influence were so completely disguised by the structure of the iron as to escape detection. I have not yet given up the hope of obtaining results in this direction, but, in the meantime, a simpler method led unexpectedly to success, and I have temporarily abandoned the first line of experiments.

A shallow vessel of thin iron containing a solution of copper sulphate was placed on the poles of a permanent magnet of Jamin's construction capable of supporting twenty-five kilogrammes. In the course of one or two minutes the outlines of the poles could be clearly seen through the solution. On pouring off the solution after allowing the action to continue for a time, the only result that could be seen was this: The copper was deposited in a fairly uniform way on the entire plate, except at the lines marking the outlines of the poles. These lines were sharply marked as depressions in the deposit, thus indicating that less action had taken place there. This experiment was repeated a number of times, the conditions being improved as much as possible. The only additional result obtained with the permanent magnet used was the development of lines other than those marking the poles, and much less regular. Between the poles, which are rectangular in shape, interrupted lines appeared parallel with the sides of the poles which were directed toward each other. These lines were produced by irregularities in the deposit of the copper. They appeared not only in the space between the poles, but at the ends of this space they curved outward, and could be followed to the outer edges of the poles, and there showed a tendency to run parallel to those between the poles. In general the direction is at right angles to the lines of force.

The result described naturally led to the inquiry whether, with a different shape and arrangement of the poles of the magnet, the copper would be deposited in similar irregular ridges at right angles to the lines of force, and a number of experiments have been performed to decide this point. First, a small electro-magnet with cylindrical poles seven inches long by one inch in diameter, and separated about three inches, was used. It was connected with a Bunsen dip battery of six cells, such as is commonly used in chemical laboratories. The iron vessel and the copper sulphate solution were the same as those used in the experiments with the permanent magnet.

The action in this case was very striking. Within half a minute, the outlines of the poles were clearly visible. A space of about one sixteenth of an inch in width followed the circular form of each pole; and, as in the case first described, the development of this space was due to the fact that here no copper, or very little at least, was deposited, leaving the smooth surface of the iron practically in its original condition. On the parts of the iron included within these circles, that is, directly over the poles, there was a fairly uniform deposit. Outside of the circles, however, the most surprising effects were produced. The greatest amount of deposit was immediately adjoining the blank circles above referred to.

From these places the copper was deposited in irregular ridges, the general direction of which it was impossible to mistake. The ridges grew less and less distinct from the poles outward, and were finally lost, in the case under consideration, at about one and a half inches from the poles. These ridges are, as nearly as could be determined, at right angles to the lines of force, and, consequently, coincident with the lines marking the equipotential surfaces. These ridges are not indistinct and difficult to recognize, but are very marked and their direction is unmistakable. The beauty of the phenomenon cannot be described nor represented.

A third form of the experiment was now tried. A large electro-magnet, connected with a battery of twelve Bunsen's cells arranged in series, was used. The construction of the magnet is such that the poles are in the same line, and the distance between them can be changed at will. The usual vessel with the solution of copper sulphate was placed in position on the poles, which were separated about two inches. Almost instantly the sharply defined outlines of the poles became visible, not a particle of copper being deposited upon these lines.

Directly over the poles the deposit was nearly uniform, as in the previous cases. Arranged over the whole plate, except the portions just mentioned, were again the remarkable ridges of copper, the direction of which changed gradually in passing from the edges of the plate nearest the poles toward the center. At first they conformed nearly to the shape of the poles, but they became less and less curved the farther they were removed, until midway between the poles they were straight and at right angles to the line joining the poles. These lines were clearly developed within a minute from the time the action began, and could be seen distinctly through the solution. On first pouring off the solution the plate presented an appearance of striking beauty, the strongly marked ridges having the pure copper color, and the outlines of the poles being free from the deposit and retaining the original brightness of the iron. I have repeated this experiment a number of times in the presence of others, and it never fails to call forth the strongest expressions of

pleasure, while I must confess that my own enthusiasm is aroused by it to an unusual extent.

Although from the results already described the general direction of the lines of copper deposited can be predicted with a considerable degree of certainty for any given case, a final experiment was performed, with such an arrangement of the apparatus as to secure the strong magnetization of a point in the center of the iron plate. The same magnet and battery were used as in the last experiment, but the magnet was so fixed in position that the line joining the two poles was perpendicular. Conical poles replaced those of truncated angular shape, and these were brought within about half an inch of each other. In this case the central point over the pole on which the vessel stood remained free from the deposit, while the ridges appeared in circles around this point, growing less and less strongly marked from the center outward. These circles could be easily distinguished for a distance of nearly two inches from the pole—the largest circles thus having diameters of nearly four inches.

As a general result of these experiments it may be stated that when copper is deposited from a solution of copper sulphate on a plate of iron in a magnetic field, it is arranged in ridges around the poles of the magnet, and in directions which are at right angles to the lines of force, and consequently coincident with the lines marking the equipotential surfaces. Further, the outlines of the poles of the magnet are always sharply defined on the plate, as along these lines a portion of the iron of greater or less width is left unacted upon.

It may be well here to give more specific directions in regard to the method of performing the experiments, in order to facilitate their repetition by others. The only difficulty is in the preparation of the iron plates. After many trials I have, for the present at least, found that plates can be most conveniently obtained in proper condition from ordinary ferrotype iron. Sheets of this may be obtained from any dealer in photographer's materials. The coating on the surface of the iron is removed by placing it in a bath of caustic soda for a short time, the process being hastened by heating. The plates, cut in sizes to suit the magnet to be used, are then bent up on all sides so as to form shallow vessels about a quarter to three-eighths of an inch in depth. To prevent rusting, it is better to leave the plates in the bath until they are needed.

After a vessel is bent into proper shape it is washed successively with water, a little ordinary concentrated hydrochloric acid, and again water. The bottom is dried, the vessel placed in position on the poles of the magnet, and the solution of copper sulphate poured in. The operations should be performed quickly, in order that the surface of the iron may be as bright as possible when the action begins. It should be observed, however, that the effects can be obtained distinctly without all these precautions, but for the best effects they are essential.

The plates appear best immediately after pouring off the solution. Then the copper has its proper color, and the parts of the iron which remain uncovered are bright; but very soon rusting begins, and before the plates are dry the color of the entire deposit, as well as of the unchanged iron, is that of the oxide of iron. All the original lines remain, however, fully as marked as at first. I have some plates which have remained for weeks unchanged, and which show the figures as clearly as on the day they were deposited. Of course, rubbing removes the deposit, so that, to be preserved, the plates should be protected in some way. I have tried photograph varnish, and this answers the purpose fairly well, though it causes the figures to appear less sharply defined than they do when uncovered.

Passing to a more important matter, we naturally ask, What is the cause of the phenomenon? In regard to this we can at present only speculate, and it is premature to speculate much on the subject as yet. There can be no doubt that the effects observed are to be ascribed to the action of magnetism, either on the iron plate or on the liquid, or on both. Experiment can decide between these possibilities. If the effect is due solely to magnetization of the iron, then non-magnetic metals will not exhibit similar phenomena; while, if it is due solely to the action of the magnet on the liquid, the same or similar effects should be obtainable with non-magnetic metals.

The question thus left open will next occupy my attention. Whether, after all the facts are established which promise to be revealed in the course of the investigation thus begun, it will be possible to frame a satisfactory theory, remains to be seen. At all events I propose to continue the study of the new set of phenomena.

In conclusion, it should be stated that a careful examination of the literature has failed to show that any experiments of the kind described in this paper have ever been performed. The only one I have found an account of which in any particular resembles mine is that of Jacobi.* This physicist desired to know whether iron deposited by electrolysis in a magnetic field is itself magnetic. To determine this he arranged an apparatus thus: A candle covered with a thin, uniform layer of copper was pinced in a cylinder containing a solution of an iron salt. The cylinder was then surrounded by a coil connected with a battery, and a current from another weak battery was passed through the iron solution, the copper cylinder forming the pole upon which the iron was deposited. After the action had continued for twenty-eight days the cylinder was removed, and it was found that the deposit was thicker at the ends than in the middle, but no lines of deposit were observed. It is questionable whether the action in this case is the same as that under consideration. I am inclined to think that the two are quite distinct phenomena, though it is possible that there is more resemblance than appears at first.—*American Chemical Journal.*

* Pogg. Annalen, 149, 341.

SELENIUM AS A HEAT REGULATOR.

THE sensitiveness of selenium to radiation is to be made use of in regulating the heat of muffle furnaces. The concentration of rays, more or less, upon selenium, influences the electric conductivity of the material, as most people know, in a marked degree, and this property M. Germain proposes to make use of to control the heating of furnaces. A window in the furnace, made of very refractive alumina glass, permits the red glow to reach a distant mirror; the rays are reflected upon selenium, and when the light reaches a certain stage of brightness the electric action of the selenium conductor is such that it acts on a mechanical arrangement by which the fire-bars of the furnace are withdrawn. The fuel of the furnace is thus allowed to fall out as soon as the right temperature for fusing enamels has been reached. The *Photo News* says: If a self-acting selenium actinometer of this kind will permit the firing of enamels with certainty, photographers will not be slow to avail themselves of it.

TERQUEM'S GAS-BURNER.

PROF. TERQUEM, of Lille, has devised a new form of laboratory gas-burner, which differs from that introduced by Bunsen in several features. In the first place, the air is not admitted at the side, but from below, whereby a more intimate mixture of air and gas, and hence a more uniform flame and a higher temperature, is obtained. The upper orifice of the burner is provided with two metallic strips crossing each other, producing four triangular openings for the escape of the gas and air. The gas enters through the nipple, *b*, and ascends through the tube, *a*. The latter may be raised or lowered at will by means of the guides at *d* and the set-screw,

TERQUEM'S GAS BURNER.

f. The character of the flame may be altered in various ways. If it is desired to avoid the contact of the flame with the bottom of a flask, etc., it may be spread out by slipping over the tube an attachment ending in a disk of copper, producing a flame like that shown in Fig. 2. The temperature which may be obtained by means of this is so high that a copper wire of 1·5 mm. diameter may be melted in any part of it. These burners are manufactured, according to the inventor's designs, by Dr. Stohrer & Sohn, Leipsic.—*Chemiker Zeit.*

FILTERING APPARATUS FOR VISCID LIQUIDS.

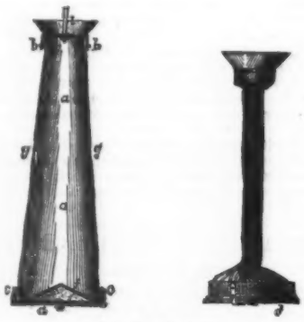
MR. J. VINCENT ELSDEN suggests an apparatus of the shape illustrated in the accompanying cut, for the purpose of filtering viscid liquids. He especially designed it for filtering photographic emulsions, but it is applicable also to other thick liquids. The flat basin contains hot water, to keep the liquid to be filtered more fluid. A wide glass tube

FILTERING APPARATUS FOR VISCID LIQUIDS.

is bent in the shape of an S, and upon one of its extremities a cup-like expansion is blown, or it is correspondingly widened. A small piece of sponge having been placed into the neck of the cup, the liquid slowly percolates through it and gradually fills the bend, from which it finally flows into the receiving vessel.—*Brit. Journ. Photo.*

TWISTING FILTER PRESS.

A SLIGHTLY conical filtering tube, made of strong cloth, is attached by its lower end to a perforated cone, *d*, forming the bottom, and by its upper end is fastened to a funnel, which is so constructed that none of the material which has passed down into the filter can leak back. The lower ring, *e*, which helps to hold the filter, is firmly secured, so that it cannot turn, and at the same time will cause the filter, when twisted, to retain a perpendicular position. When the interior of the filter is filled it has the shape of the figure shown on the left of the cut. The upper end is then caused to be twisted by means of suitable belting, when it will finally assume the shape shown on the right. As soon as all the liquid is pressed out, the dry material is discharged by untwisting the filter and releasing the bottom, which opens downward on a hinge.



GIGOT'S FILTER.

ESTIMATION OF BUTTER.

By L. MEDICUS and S. SCHERER.

THE authors pronounce the method proposed by Reichert for the analysis of butter to be the most correct in principle, and they apply it in determining whether the composition of butter is unaffected by melting and subsequent congelation. They find that those portions of the mass which are the last to cool retain the largest proportion of the volatile fats. Thus an average sample of butter, 2·5 grms., required for saponification 14 c.c. decinormal soda. The bulk was then melted, allowed to cool spontaneously, and different parts of the mass were analyzed. The upper layer required 13·3 c.c.; the bottom, 14·2; the sides, 14·4, and the middle, 17·3. The authors point out the necessity of great care in sampling butters and fats for analysis. In conclusion they give a table showing the quantity of decinormal soda consumed by 2·5 grms. butter as compared with other fats and oils: Butter, 14 c.c.; lard, 0·2; turnip-seed oil, 0·3; rape oil, 0·4; oil of sesame, 0·35; olive oil, 0·3; and palm oil, 0·3.

DETECTION OF PHOSPHORUS.

By F. SELMI.

THE urine passed on the first day gave the following results: it gave off a volatile product capable of reducing silver nitrate without affecting lead acetate. It contains a small proportion of albumen; it contains one of the mineral acids of phosphorus, or at least a compound which is capable of precipitating baryta in an alcoholic solution, and which in presence of nascent hydrogen gives off hydrogen phosphide. It yields a volatile phosphoric product, ammonia, and two volatile bases (one containing phosphorus); these substances distill over along with alcohol. It yields two other non-phosphoric bases, one fixed and the other volatile, which are extracted by chloroform from the aqueous residue after the distillation of the alcohol. Along with the volatile base is found a small quantity of a product having the odor of conicine. The odor of trimethylamine is also perceptible. In doubtful cases the author considers that an examination of the urine yield valuable data.

PHOSPHORUS.—SYMBOL P.—COMBINING WEIGHT, 31.

THIS element is widely distributed in nature, and occurs chiefly in the form of phosphate of lime. Large masses of rock, such as apatite, are found in some parts of the world, which consist of almost pure phosphate of lime, and this element is also a constituent of guano and other deposits of animal refuse. Phosphorus is present in all vegetable and animal tissues; grain of all kinds contains phosphorus, and therefore phosphates are essentially necessary in soils, and if absent have to be added artificially. The bones of animals are very rich in phosphates, and phosphorus also exists in other states of combination in the blood, brain, milk, in fact in all tissues and secretions of animals. Yeast is a substance particularly rich in phosphorus; when yeast is burnt the residual ash consists of more than half its weight of phosphoric acid. The ash of barley and other grains also contains a considerable proportion of phosphates, and it may be safely said that this element is but rarely absent from any organic structure. Phosphorus is prepared from bone ashes by first heating them with dilute sulphuric acid, by which a superphosphate or soluble phosphate of lime is formed; the solution of this body is mixed with charcoal and evaporated to dryness, and the mixture subsequently heated in a retort, when phosphorus distills over and may be collected under water; the charcoal acts as a deoxidizing agent and takes away the oxygen from the phosphoric acid, leaving the phosphorus in a free state. Phosphorus, at ordinary temperature, is a semi-transparent yellow solid, resembling beeswax, which may be cut or moulded to any shape; it is insoluble in water, but dissolves in certain oils and a liquid called bisulphide of carbon. Phosphorus melts at 108° F., and boils at about 500°, giving rise to a colorless gas. The most remarkable property of phosphorus is its inflammability, in fact it is from this that its name, signifying light producer, is derived; exposed to the air, it inflames at a temperature of about 120° F., but it commences to combine with oxygen at much lower temperatures and long before active combustion commences; this property makes phosphorus a useful agent for separating oxygen from gaseous mixtures. Great care must be taken in handling phosphorus, as the warmth of the hand is sometimes sufficient to inflame it; slight friction or a sharp blow will also light it; this characteristic property of phosphorus is practically applied in the production of matches. Phosphorus resembles sulphur, and undergoes several allotropic modifications; when heated away from oxygen for several hours to a temperature of about 450° F., it gradually loses its transparency, and ultimately is converted into a red powder, which consists of nothing but phosphorus, but in a profoundly modified form; in this state it is no longer inflammable at low temperatures, does not dissolve in the usual solvents, and, unlike ordinary phosphorus, is not poisonous.

It is this allotropic modification of phosphorus, which is so much easier to control, that is now used in the manufacture of matches. At an even higher temperature, this modified phosphorus reverts back to its original active state, in this respect also resembling sulphur.

There are two oxides of phosphorus known, viz., phosphorus trioxide P_2O_3, and phosphorus pentoxide P_2O_5, forming respectively the two acids known as phosphorous acid and phosphoric acid.

Phosphorous Acid, H_3PO_3.—When phosphorus is burnt with a limited supply of oxygen, phosphorus trioxide is formed, which separates in the form of white powder; this rapidly absorbs moisture, producing phosphorous acid. This acid is also formed when phosphorus is exposed to the moist atmosphere. Phosphorous acid rapidly absorbs oxygen, and is ultimately converted into the acid of the higher oxide. This acid and its compounds have no real practical importance.

Phosphoric Acid, H_3PO_4.—When phosphorus is burnt in excess of oxygen or air, the pentoxide is formed; at first it appears in the form of dense white fumes, but by degrees these settle down into a white amorphous powder. This oxide also has an extraordinary affinity for water, and forms with it the true phosphoric acid. By substitution of different metals for the whole or part of the hydrogen in H_3PO_4, a series of salts called phosphates are formed, many of which have important uses in the arts. It may be convenient on the present occasion to use these phosphates as illustrations of what the chemist understands by *substitution products*. Phosphoric acid is represented by the formula H_3PO_4, and by chemical operations, which we need not explain in detail, it is possible to wholly or partially replace the hydrogen by metals. The following table gives a few examples of the substitution compounds, which it will be seen are all founded on the same type:

H_3PO_4. Phosphoric acid.
H_2NaPO_4. Dihydrogen sodium phosphate.
HNa_2PO_4. Hydrogen disodium phosphate.
Na_3PO_4. Trisodium phosphate.

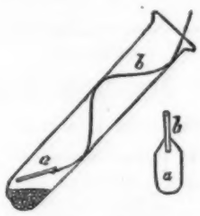
Instead of all the hydrogen being replaced by one metal, it may be substituted by two or more, and thus more complicated salts are formed. The two intermediate phosphates

of sodium, referred to in the above table, can be made to yield acids which differ in some points from ordinary tribasic phosphoric acid. Thus, the second member of the series yields pyrophosphoric acid, $H_4P_2O_7$, and the third yields metaphosphoric acid HPO_3.

There is another oxygen acid of phosphorus, called hypophosphorus acid, which also forms a series of salts called hypophosphites; but their study does not come within the scope of these papers. Phosphorus also combines with other elements, in this respect somewhat resembling nitrogen, but none of these compounds have any practical importance.—*Brewers' Guardian.*

A DELICATE TEST FOR MERCURY.

A VERY delicate reaction for mercury is thus given by Biewend. The substance to be examined for mercury is intimately mixed with twice its bulk of finely divided metallic copper (obtained by precipitating a solution of sulphate of copper with metallic iron), the mixture introduced into a small test-tube, of about 15 mm. diameter, and a brightly polished disk of gold, *a*, fastened (see *b*) to a spirally bent watch-spring, introduced so that the disk is immediately over the mixture. The spiral twist of the spring causes the disk to be retained in its place. The test-tube is then heated cautiously in a slanting position, by applying the flame below until the bottom of the test-tube begins to



be red-hot, at the same time taking care that the gold disk does not become too hot. The amalgamated disk, after removal, is to be washed with alcohol, if the substance in which mercury was looked for was of a bituminous character. The mercurial mirror may be removed by heating the disk red-hot; but the latter will have a dull appearance on cooling, wherever it had been amalgamated. To restore the former brightness, the disk is laid on a flat surface, moistened with a few drops of water, and then rubbed over a few times with a thick steel knitting-needle held horizontally. This smoothens down and depresses the irregularities of the surface, and the disk becomes perfectly bright.

The above test will reveal the presence of as small a quantity as 0·08 milligramme.—*Dingler's Pol. Journ.*

ON A CURIOUS ACTINIC PHENOMENON.

By DR. T. L. PHIPSON, F.C.S., etc.

HAVING seen a paragraph in several English and foreign periodicals relating to a novel actinic phenomenon discovered by me some time ago, it will be, perhaps, expedient to publish all I know at present upon this singular occurrence. In the first place, it is necessary to state that the phenomenon in question was first noticed by my friend, Mr. Thos. Griffiths, F.C.S., who called my attention to it more than a year ago, and requested me to investigate the cause of it.

The first observation was that a gate post painted white by means of a new white pigment having a zinc basis appeared black all day and white all night, turning black again soon after sunrise, *et ainsi de suite*, for any number of days.

The white pigment was prepared by precipitating a solution of sulphate of zinc by another of sulphide of barium, and its analysis gave me the following results:

Loss by calcination	1·62
Sulphate of baryta	41·50
Sulphide of barium	1·02
Protoxide of iron	2·12
Oxide of zinc	16·30
Sulphide of zinc	37·44
Lead, arsenic, manganese, etc.	traces
	100·00

I found that when this white powder was spread upon a piece of paper and exposed to the direct rays of the sun, it became fawn colored, brown, and finally a dark slate color in the course of about twenty minutes. When in this state it was placed in darkness it became white again in 2½ to 3 hours time.

The phenomenon was doubtless due to the use of sulphide of barium in the preparation of the pigment; for specimens made by another process in which no sulphide of barium is used did not show it at all.

The property possessed by sulphide of barium of becoming phosphorescent after insolation has been long known, but the explanation of this curious phenomenon is no further advanced now than when my little volume "Phosphorescence, etc.," appeared in 1863, unless the recent interesting electric experiments by Mr. Crookes, F.R.S., supply the key to the enigma.

In the present case, however, no phosphorescence is observed when the insolated pigment is carried into a dark place during the time it is undergoing coloration by the direct influence of the solar rays.

Another curious fact soon struck me, namely, that if a piece of glass were laid over the white pigment when exposed to the sun, it did not darken, however thin the glass might be; while the half of the specimen which remained uncovered took a very dark slate-color in about half an hour; that which was protected by the glass was nearly as white as at first, and it took from 4 to 8 hours' exposure to direct sunlight to give to this portion under the glass a very slight fawn-color.

Of course these phenomena could not be due to any compound of silver; nevertheless, the specimens were tested for silver, and with great care, but without the slightest result. In fact, no actinic substance has been met with that will *darken in the sunshine, become white again in the dark, and will not darken under a sheet of ordinary window glass.* It was hinted that I was dealing with a new element (to be called "actinium"); but the continuation of my experiments lead me to believe that the phenomena described above may probably be due to the presence of *sulphide of barium* and *protoxide of iron* in the specimens, rather than to some unknown metal.

I observed that the dark slate colored product was immediately soluble in cold acetic acid (as sulphide of iron is); and if the dark color be due to the production of sulphide of iron, the return of the pigment to its original white tint when placed in darkness for some hours, may be owing to the gradual oxidation of this sulphide of iron and consequent disappearance of the dark color.

The baryta soluble in acid found in the analysis is calculated as sulphide, and the iron as protoxide (as it exists in the *proto* state), but the pigment may really contain some compound oxysulphide of zinc, iron, and barium, which has the property of turning black in the sunshine by the carrying of sulphur on to the iron during insolation; and the black sulphide disappearing by gradual oxidation when the stuff is placed in the dark would account for its reassuming its white tint.

I find also that a strong calcination, with free access of air, destroys, or considerably hinders, the production of the actinic phenomenon. I have also observed that although the pigment will retain this property of darkening in the sunlight for more than a year, some specimens have lost this property in a few months; and a gate post painted white, after darkening, in the manner above mentioned, for the space of several days, will at last remain white.

All this points to the probability of the above explanation, but the matter is still under investigation.—*Chemical News.*

THE CAT AND ITS RELATIONS.*

By FREDERIC A. LUCAS.

IN taking for our subject the cat and its relations, we will consider it as an animal entirely new to us, and that we wish to ascertain as near as may be the position it holds in regard to other animals, and set it in that place as we would a book in a library. In other words, we wish to *classify* it. Now this very interesting and very difficult problem of classification is one that has long occupied the attention of scientists, and is still far from being satisfactorily settled. System after system has been proposed, only to be overthrown or modified by subsequent investigation, and although the methods of research now at our disposal are far beyond those of any previous age, the chain connecting the highest and lowest members of any great division is far from complete. One important reason for this lies in the fact that many of the links have been lost by the extinction of entire races of animals, which are only imperfectly known to us by their fossil remains. At best but a small portion of the globe is available for paleontological research, and when we reflect upon the large number of new forms already discovered in that limited area, we gain an idea of the number that are still totally unknown.

METHODS OF CLASSIFICATION.

As it is, we have among extinct animals five orders of reptiles, one of birds, and two of mammals, that are without living representatives. I recently spoke of the *chain* connecting the members of a group; but this is really a bad simile, unless we consider it a very crooked chain, for no system of classification proceeds in a straight line. The highest animals in any given group are often above the lowest forms of the next, so that really it is like climbing a lofty mountain range, where, although our progress in the main is upward, yet we often find ourselves going down hill. There is one method of classifying the higher animals that would naturally suggest itself, and that is form and habits, and this was employed to some extent by the ancients. Animals, they said, walk, fly, creep, or swim, and we will divide them accordingly. This, at all events, was a beginning; but it gave rise to some grouping that seems to us very strange. For example, it brought together bats and birds, although this, after all, was not so bad a mistake as it might have been, for there are plenty of people now who have an idea that a bat is a kind of bird, and our German friends call it a flying mouse. Seals, whales, and fishes were also more or less thrown together, and some lizards were placed with the snakes. Even as late as 1680, an English naturalist took pains to form a definition which should include whales and fishes. But little by little, as animals became better known, external appearance became less and less trusted, and other methods were resorted to. Now, as in arranging a library, you would not be guided by the bindings or external appearance of the books but by the contents or internal structure, so in modern systems of classification; all the large groups are based on similarity of structure, and external characters are only used in defining the smaller divisions. In the solution of knotty questions, no point, however small, is neglected. For example, in determining the position of a bird, its anatomical relations are carefully considered, and next, the manner in which it is covered with feathers—for this varies greatly. The number of the wing and tail feathers is noted, together with the general texture of the plumage. The appearance of the new-born chick is an important point, and the structure of the nest and even the number and form of the eggs all help.

THE CAT DESCRIBED.

As we would first look at the title of a book, and then at its contents, we will glance briefly at the external appearance and internal anatomy of our cat. Externally it is a small fur-clad animal with a rounded head, moderately long ears and tail, and eyes with a vertical pupil. An investigation of its anatomy shows that the skull is rounded, and articulates with the first vertebra of the neck by two projections or condyles; that the canine teeth are long and powerful, and the grinders few in number, and mostly sharp-edged. After saying that the head was round, it may have seemed superfluous to say that the skull was also; but that one does not always conform to the other is shown by examination of the head of the porpoise.

We find seven neck vertebræ, thirteen dorsals or rib-bearing vertebræ, seven lumbars, three sacrals, to which the hip bone is fastened, and eighteen caudals. The clavicle or collar bone is very small, and the bones of the limbs are quite round, and so jointed as to give great freedom of movement. The fore foot has five toes, the hind foot but four, all incased in sharp claws. We notice two peculiarities about the feet: first, that the sole of the foot is not applied to the ground, but that the animal walks on tip-toe; and secondly, that there is a peculiar but simple mechanism for drawing back the claws so that they do not touch the ground in walking. In comparing our cat with other animals, we will choose the more obvious characters, and by preference those peculiar to the skeleton, as those are the most important, and last after the soft tissues have decayed. It is only by means of skeletal peculiarities that we are enabled to form any idea of extinct vertebrates, and it may not be too presumptuous to compare astronomy to osteology, since by one we grasp the distant in space, and by the other the distant in time.

TWO GREAT GROUPS.

Taking structure as our base of operations, we find that there are two great groups or sub-kingdoms into which animals can readily be divided. Examining a worm, snail, butterfly, or lobster, we find that hard parts to which the muscles attach are on the outside of the body. A fish, frog, bird, or mammal has, on the contrary, an internal framework or skeleton, consisting of a chain of vertebræ, to which are appended ribs and limbs. The first is termed *Invertebrata*, and the second *Vertebrata*, and to this latter the cat evidently belongs, as it has a very complete skeleton. Hence our first step has been to decide that the cat is a vertebrate. There are five great modifications of the vertebrate plan, forming as many classes.

FISHES.

The lowest of these, *Pisces*, comprises all fishes, and is distinguished by the possession of median fins, supported by bony rays, and by limbs which cannot be divided into upper arm, forearm, and hand. Moreover, a breast-bone or sternum is almost invariably absent. Fishes, too, are never clothed with hair.

Referring to the cat, we recognize that it cannot be a fish, since it has no fine rays, and has limbs whose divisions are well marked.

AMPHIBIANS.

The second class, *Amphibia*, contains all frogs, toads, and salamanders, besides a few small snake-like animals termed Cæcilians. These cæcilians, by the way, are interesting from certain characters they have in common with the extinct labyrinthodons. The amphibia have affinities both with reptiles and fishes, but are distinguished from the former by having a skull with two condyles, and no cartilages running from the ribs to the sternum, and from the latter by the absence of fin rays, and by having the limbs, when present, divisible into three parts. The amphibia are nearly all small animals, breathing by gills when young, and both by gills and lungs, or lungs alone, when adult. Each half of the lower jaw is composed of several pieces, and does not join the cranium directly, but by the interposition of another bone. Usually amphibia are covered with a smooth, moist skin. Although the cat has two occipital condyles yet the lower jaw is formed of but two pieces, and joins the skull directly. Moreover, the ribs are joined to the sternum by cartilages, and evidently the cat is not an amphibian.

THEIR TRANSFORMATIONS.

Many of the amphibia undergo some wonderful transformations, which it may be worth while to notice. If Stanley had told us that he had discovered in Lake Tanganyika a fish which, after living for some time in the water, shed its gills and tail, and afterward passed the greater part of its life on land, we should be much inclined to disbelieve Mr. Stanley. However, as this animal dwells in every pool, and is simply called a pollywog, we see nothing remarkable in it. Living in Mexico is a little lizard-like animal known as the axolotl. As it has both lungs and gills, it is a very typical amphibian, and as it reproduces its species it would seem to be a perfect animal, reproduction being usually considered a good test of maturity. But under certain conditions, one of which seems to be lack of water, the axolotl loses its gills entirely. The skin is shed several times, and the tail becomes round instead of vertically flattened. The eyes also increase in size, and the skin changes color. The result of this metamorphosis is a terrestrial salamander of the genus *Ambiystoma*.

REPTILES.

The third class, *Reptilia*, is composed of such widely different forms as crocodiles, lizards, snakes, and turtles. Varied as they are in external appearance, all agree in the following structural peculiarities: The skull, which has but one condyle, is joined to a short neck, of at the most nine vertebræ. The iliac bone of the pelvis projects much farther behind the socket for the thigh-bone than in front of it, while the pubes unite with one another. Each half—or ramus—of the jaw is formed of five pieces. The reptilia are usually covered with horny scales, and, as well as amphibians and fishes, have cold blood.

BIRDS.

The double condyle and lower jaw of but two pieces rule out the cat from the class reptilia, and we pass to that of *Aves*, or birds. Birds are, of all animals, those most readily distinguished by their outward appearance, and can be described in four words as *animals clothed with feathers.* No other animal possesses feathers, and no bird is without them. Even where the feathers are so loosely webbed as to appear slightly like hair, as in the apteryx, emu, or cassowary, the resemblance is entirely superficial, and no one would mistake a feather of either for anything else. The skeleton of a bird bears a certain resemblance to that of a reptile; but while reptiles have short necks and long bodies, birds have long necks and short bodies. Birds have never more than three fingers, reptiles never less than four, when they have any. The sternum of birds never has ribs attached to its hinder margin, as in reptiles, and by referring to the diagram we find a different arrangement of the bones of the pelvis. Besides, birds have a peculiar curved process, termed the uncinate process, on the hinder margin of the rib, which is very rarely found in reptiles. Birds and reptiles have been united in a so-called province, and although at first sight there seems no bond of union between a bird and a snake, yet by the aid of fossils we are enabled to bridge the gap between them. Here is the skeleton of a crow, in which we notice the keeled sternum, toothless beak, and short tail, and here a rough restoration of the *Archæopteryx*, which shows a vast departure from any modern bird. There are teeth in the front of the mandible, a total absence of a sternum, no hooked projection on the ribs, and an extremely long tail. Besides all this, the Archæopteryx was provided with feathers only on the thighs, wings, and tail. Intermediate between the Archæopteryx and modern birds are the toothed birds discovered by Prof. March, and which were provided with teeth in both jaws, except at the lips, just where they are found in Archæopteryx. Thence it is an easy step to those extinct flying lizards, the Rhamphorhynchus and Pterodactyl, which had three and four fingers of the hand at liberty, the wing being sustained by the enormous little finger. Remove the membrane and shorten the finger, we get an ordinary lizard, and we complete the change by means of the seps, a small lizard with elongated body and very small legs, and the pseudopus, which externally has no limbs at all.

* A paper read before the Rochester Society of Natural Sciences.

MAMMALS.

Returning to our cat once more, we find that the same peculiarities of the skull which separated it from the reptilia separate it also from aves, and, moreover, the cat, and for that matter no mammal has any processes on the ribs. We have left but one more class in which to search for a place for the cat—the class *Mammalia*. Mammals differ vastly in exterior appearance. Usually they are clothed with hair, but they may be entirely naked, as are the whales. Some are defended by a bony armor, like the armadillos, and others arrayed in horny scales like the manis. Mammals may walk, swim, or fly; they may live entirely in the water, as do the whales, in the tree-tops like the sloths, or underground after the manner of the moles. But in spite of these apparently great variations the members of this class, when divested of their soft parts, are found to depart less from a given plan of structure than any other class of vertebrates. They never possess more than seven neck vertebræ, while birds vary from nine to twenty-three; they never have more than twenty-four pairs of ribs, while reptiles have from nine to two hundred and sixty pairs, and fish none up to at least sixty. Mammalia agree in the following points: The number of cervical vertebræ is always seven. We say that this number is constant; but as there are exceptions to all rules, so there is to this, for the manatee and Hoffman's sloth have only six, while the three-toed sloths have nine. There is also a change in the structure of the vertebræ themselves. In mammals the body of each vertebra consists of one large piece or centrum, capped on either end by a thin disklike bone termed an epiphysis; but in the four lower classes the body of the vertebra is quite solid.* Then we have two occipital condyles in conjunction with a jaw, each half of which is a single bone articulating directly with the cranium.

THE CAT A MAMMAL.

Now the cat has all these characters, besides agreeing in other respects with the mammals, having, for example, a heart, with two auricles and two ventricles, a complete diaphragm, and being covered with fur. Thus, by comparison with the various classes of vertebrata, we have reached our second conclusion, namely, that the cat is a mammal, and our next inquiry is: To what *order* does it belong?

MONOTREMATES.

There are fourteen orders of mammalia, the lowest of which is that of *Monotremata*, and contains but two species, the echidina and duck-billed platypus, animals which, in some anatomical points, resemble reptiles and birds; so much so that it was formerly thought possible that the young, like chickens, were hatched from eggs. One of these points is the possession of a T-shaped bone called the inter-clavicle, which joins the sternum, and to which the collar-bones are attached. This bone is found in reptiles. Another peculiarity is the bony sternal ribs connecting the ribs with the breast bone, a similar arrangement to that found in birds. The cat hardly has a collar bone, much less an interclavicle, and so we pass to the curious order of *Marsupialia*, or pouched mammals.

MARSUPIALS.

This order, although large, is almost entirely restricted to Australia, and, among other things, is interesting from the manner in which certain of its members imitate many of the higher mammals. Thus we have rodential marsupials, others like the dasyurus that are carnivorous, and while the kangaroos suggest the ruminants, the phalangers point to the lemurs. The marsupialia are distinguished by the turning in or reflexing of the hinder part of the lower jaw, and by the presence of two small bones projecting forward from the front of the pelvis. The reflexing of the jaw may appear a slight matter, but it is really of great importance. It is, as you are aware, often asserted and quite popularly believed, that a skilled anatomist can reconstruct an entire skeleton from a few bones or teeth, and then proceed to describe the animal's form and habits. This, I am sorry to say, is a very erroneous idea, for ordinarily the best that can be done is to make an approximation to what the animal was. In this connection I cannot do better than to quote from Huxley the following;

"Although we know the skull, the dentition, and the most important of the limb bones of toxodon, no one ventures to predict the characters of its feet, much less to say anything about its internal organization. Even its zoological affinities are extremely doubtful, and it is hard to say whether toxodon is merely an aberrant ungulate or the type of a new order."

Usually, however, there is a fixed relation between the parts of an animal's skeleton, and again between that and the outward form and mode of life.

Cuvier decided, from the fragment of a jaw, that it belonged to an opossum, and his opinion was confirmed by the subsequent discovery of the skeleton. Now Cuvier's judgment was largely based on the reflexing of jaw to which we recently alluded, and it would be pretty safe to predict of any similarly shaped jaw that it belonged to an animal having nineteen trunk vertebræ and marsupial bones, and that the young were born in a very feeble state, and guarded by the mother in a pouch. So that this slight peculiarity is really the key to the entire structure of the marsupials.

EDENTATES.

As the cat has no marsupial bones, and as its jaw is not bent in at all, we decide not to place it with the marsupials, and go to the next order of *bruta* or edentates. This contains a number of curious animals that differ not only in external appearance but in structure and mode of life. The sloths are covered with thick hair, and live wholly in the trees, while the armadillos, who have a bony carapace, burrow in the ground, and the pangolins are protected by overlapping horny scales. Among other peculiarities the long-tailed manis rejoices in forty-six caudal vertebræ, the greatest number found among mammals. On the other hand, the two-toed sloth has but four, but is furnished with twenty-four pairs of ribs, the greatest number in the class, and the three-toed sloth has the exceptional number of nine cervicals. In spite, however, of these great differences, all agree in the absence of incisor teeth, while some are wholly toothless. In those members that have teeth, the teeth are without enamel, and grow throughout life. The bones of the limbs are very solid and reptilian in their structure.

RODENTS.

Possessing incisors, and teeth crowned with enamel, and having hollow bones, the cat, we conclude, does not belong to the bruta. If the order just considered is distinguished by the absence of incisors, that of *rodentia* is characterized by their presence in a highly specialized form, and by the absence of canines. The incisors, which are two in number, both above and below,* continue to grow as long as the animal lives, and by a simple arrangement are kept sharp. The dense enamel is placed almost wholly on the front of the teeth, being very thin, or even absent on the back. Consequently the posterior portion of the tooth wears away rapidly, leaving a chisel-like cutting edge. Indispensable as the growth of the tooth usually is, it sometimes becomes inconvenient or even dangerous. If a rodent loses an incisor, the one opposed to it meets with no resistance, and keeps growing until it has been known to penetrate the brain. The six incisors of the cat, with their crowns covered with enamel, and not growing continuously, preclude it from being a rodent.

INSECTIVORES.

The *Insectivora* are small animals which, as the name indicates, live chiefly on insects. Among them are found the shrews, the smallest of all mammals. This group is hard to define, but is distinguished from the small carnivores with which it runs any risk of being confounded, by the numerous grinding teeth being furnished with sharp tubercles, and by having a collar bone. The cat is easily separated from this order.

BATS.

The *Cheiroptera*, or bats, are closely related to the insectivora. They are easily known by having the fore limb formed for flight, and are the only mammals that do fly, the so called flying squirrels and flying lemurs merely having a membrane extending from the side of the body to the wrist and ankle, of sufficient extent to act as a parachute. From the structure of the fore limb we conclude that the cat does not belong among the Cheiroptera. In the wing of the bat we have a good example of how nature employs different methods to accomplish similar results. The wing of the bird is formed of feathers attached to two united fingers. The pterodactyl had a membraneous wing running from the body to the enormously lengthened little finger, three or four digits being at liberty. Finally, the bat's wing is formed by a membrane supported by four fingers, only the thumb being free.

WHALES.

The members of the order of *Cetacea*, or whales, are recognized by their fish-like form, the absence of hind limbs, the paddle-like fore limbs, and the position of the nostrils, which are placed on top of the head. Not having any of these characters, and moreover, being covered with thick fur instead of shiny naked ski we naturally do not call the cat a cetacean. In the bats we had an order formed for navigating the air, and in the whales we have one framed exclusively for life in the water, locomotion being performed as in fishes by the powerful tail. We noted in the commencement that whales were formerly considered as fishes; but a very cursory comparison of one—say a porpoise—with a perch, shows that in spite of exterior resemblance there is a wide difference between them.

First we notice that while the fish has a vertical tail and breathes by gills, the porpoise has a horizontal tail and respires by lungs. A little dissection shows that the porpoise has seven cervicles, a sternum, no fin rays, and a paddle formed on this plan, and that the fish possesses fin rays, no sternum, and a certain kind of fin.

The whales are not only the largest living beings, but it is only very recently that any fossils have been discovered that indicate the previous existence of any animals of equal bulk. The indiscriminate use of the words huge, monstrous, immense, would give the impression that the animals of to-day are far inferior in size to their predecessors; but the fact is that none of the extinct reptiles upon whom so many large sounding adjectives are lavished even approach the dimensions of a moderate sized whale.

MANATEES.

Closely resembling the whales are the members of the order *Sirenia*, or manatees. They are, however, much less fish-like in appearance, have a shorter skull, different dentition, and nostrils opening nearly at the end of the muzzle instead of on top of the head. Their anatomy bears a strong resemblance to that of the Ungulates.

[To be continued.]

* The *Monotremata* have no epiphyses, and in the Sirenia they appear late in life, if at all.

* The *Leporida*, or hares, have two small upper incisors directly behind the others.

GETTING RID OF THE RATS.

RATS seem to be a necessary concomitant of civilization and increase in number at a rate which is marvelous. Wherever men collect together the rats follow, and in cities, especially old cities, their numbers are legion. Mills and granaries are the paradises of rats, and it seems almost impossible to clear such premises of them. We have often given accounts of successful remedies for the trouble; but successful rat-remedies are quite as numerous as successful remedies for toothache, and yet there is a great deal of toothache in this world. Still, there is no harm done in trying simple and inexpensive remedies, and we append a few which have been suggested by correspondents of the *Country Gentleman*. One correspondent of that excellent paper writes: "I saw last summer a large cellar under an old building, whose owner informed me that the walls were honeycombed with the runways of rats. At that time the lady of the house told me that not a rat was either visiting or domiciliating in that cellar, or its numerous burrows. Her remedy was to make a strong solution of copperas water, and paint the walls of the whole cellar, then to pound up copperas, and scatter it along the sides of the walls and into every hole where it could be thrown, or profusely thrust therein. In two weeks every rat had disappeared. A gentleman informed me that he had driven rats from his house by feeding them liberally for several days on a smooth surface, then afterward dampening the floor and smearing it with caustic potash; the rats, in running over it while feeding at his bait, got their feet besmeared with it, which caused a burning or corroding of the flesh. At the same time they lick their feet to relieve the pain, and were either so annoyed or poisoned that they left his premises. I think he said he put some sticky or glutinous substance on the floor when it was moistened."

Another correspondent says: "I have used the following plan with instant and unfailing success: Procure copperas and sprinkle wherever they are likely to run, in and about their holes. Make it very fine, so as to enter the pores of their feet, and my word for it, you will be safely delivered of rats in forty-eight hours. They always migrate to the nearest neighbor's premises."

A Pennsylvania gentleman furnishes the following to the same journal: "For years I have made it my study to destroy in some easy way this curse to farmers, and after four years of experience, I give it to the public. Trapping is slow and not sure; poison has its objections, but oil of vitriol is sure to take every foot off, a part of each tail, and the end of each nose. Procure four pounds of oil of vitriol in a bottle having a strong ground stopper. It is very heavy, and will keep good for years. I have had some four years and have poured it out and back again a dozen times, and, except its turning brown, it is just as it was when I got it. You can bait them wherever you please—into a dry-goods box, an old hogshead, or grain-house. I cut a three-inch round hole in a handy place in my grain-house, four inches from the floor, and let rats and all run out and in as they will, but I am sure they cannot get in anywhere else. When I am ready I set an earthen meat plate, twenty inches long, ten or twelve wide, and two deep, with the end to the side of the box or building. I then put in the hole a tin spout, that will wedge tight. It is eight inches long, and one inch and a half in diameter at the inside end. I then fill the plate almost full of acid, and keep children away, and I am careful in putting it back into the bottle. I pour it into a pitcher, or some earthen vessel that has a spout. I press the inner end of the spout down, but not so low as to touch the acid."

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